

SITE: AMERICAN CREOSOTE
BREAK: 86
OTHER: vol. 1

SUPERFUND FIVE-YEAR REVIEW REPORT

AMERICAN CREOSOTE WORKS SITE JACKSON, TENNESSEE

JULY 2004

10115050



ACW, JACKSON, TN- FIVE-YEAR REVIEW REPORT
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**First OU2 Five-Year Review Report
American Creosote Works, Jackson Tennessee**

List of Acronyms

ACW	American Creosote Works
ARARS	Applicable or relevant and appropriate requirements
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
ESD	Explanation of Significant Differences
IC	Institutional Controls
MCL	Maximum Contaminant Level
MW	Monitoring Well
NCP	National Contingency Plan
NPDES	National Pollution Discharge and Elimination Standard
NPL	National Priorities List
NRMRL	National Risk Management Research Laboratory
PCP	Pentachlorophenol
ppb	parts per billion
RD	Remedial Design
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
S/S	Solidification/Stabilization
UCS	Unconfined Compressive Strength
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

EXECUTIVE SUMMARY

The American Creosote Site in Jackson, Tennessee was discovered by the State officials in 1981, and was placed on the NPL in 1984. The site was a wood preserving facility which used creosote and pentachlorophenol in its operations. Site soil and groundwater were contaminated with these compounds during the operations at levels that posed human health and environmental hazards. The operator did not address the problem before filing for bankruptcy in 1982. Therefore, EPA and the State have been responsible for conducting the necessary clean-up activities which began in 1981, and are still on-going.

Wastes and other hazardous materials stored on-site and abandoned by the operators were removed and properly disposed of under EPA's emergency response authority in 1983. Other activities aimed at protecting surface water, discouraging trespassing and preventing accidental exposure to contaminated soil were conducted as Operable Unit 1 RA in 1984. In September 1996, EPA issued the Operable Unit 2 Record of Decision which focused on the contaminated soil cleanup and the monitoring of groundwater, surface water, and sediment. The soil cleanup was conducted in 1999 using stabilization/solidification (S/S) technology. Monitoring of groundwater, surface water, and sediment began in June 2000, and will end in May 2005, in accordance with the OU2 ROD requirements. Site Operations and Maintenance (O & M) which is the State's responsibility will begin in June 2005.

This report is the first Five-Year Review of the soil and groundwater Remedial Action or the OU2 RA. The Review is a statutorily required evaluation of current site conditions relative to the cleanup activities conducted at the site to date. Two previous Reviews of the site were conducted to evaluate the performance of the OU1 RA. The Reviews were conducted in 1995 and 2000 respectively.

As part of the evaluation of current site conditions, soil samples collected during and after the S/S construction were analyzed and compared to the remedial action goals and the remedial design criteria. It was determined that the affected soil was remediated to the desired standard. As a result, the site is available again for industrial activities. In fact, it has been acquired recently and it is being used by the purchaser, Jackson Energy Authority (JEA) for equipment storage.

Groundwater sampling information was analyzed also. The conclusions were that site contaminants remain in the groundwater within site boundaries at concentration levels comparable to the levels before the soil was remediated indicating that the local groundwater is prevented from deteriorating by the remedy. The site is precluded from being used for residential purposes by the local zoning ordinance. Therefore, no on-site domestic wells are expected to penetrate the aquifers in the future. In addition, EPA and the State included site use restriction clauses in their separate property acquisition agreements with JEA. Groundwater outside the site

indicated elevated levels of site contaminants after soil remediation. However, the concentration trends and current levels do not appear to pose a threat to human health or the environment.

The main observations made during this review and the recommendations for addressing them are as follows:

1. Liquid waste containing creosote was drained from the contaminated soil as part of the solidification/stabilization project. However, certain monitoring wells have indicated recently that additional recovery of such waste is necessary. It is recommended that the waste be recovered periodically by pumping the affected wells and disposed of at an appropriate offsite location. However, funding of such work after the ongoing RA officially ends in May 2005, would require a decision document such as an Explanation of Significant Differences (ESD).
2. Groundwater has been sampled bi-annually since June 2000. In the final year of monitoring required by the OU2 ROD, it is recommended that the groundwater be sampled quarterly to allow adequately for the effect of seasonal weather conditions on contaminant concentrations.
3. A recent tornado, which went through the area, damaged the site fencing and left debris on-site. The fence should be repaired immediately to control un-authorized access and the debris should be removed.
4. Low spots and bare areas were observed on the treated and capped soil. The low spots require fill dirt and the affected portions of the cap should be re-seeded to maintain effective run-off of precipitation.

Based on available information, this Five-Year Review indicates that the remedy implemented at the site is effectively protecting human health and the environment. The Review concludes that the site should remain safe in the long-term if the issues identified in this report are addressed appropriately.

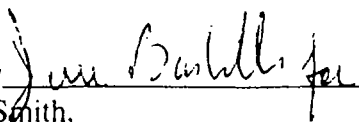
ACW SITE FIVE -YEAR REVIEW SUMMARY FORM

SITE NAME: AMERICAN CREOSOTE WORKS EPA ID # TND007018799		
REGION: 04	STATE: TN	CITY/COUNTY: JACKSON/MADISON
LTRA?: NO	CONSTRUCTION COMPLETION DATE : MAY 15, 2000	
FUND/PRP LEAD: FUND	LEAD AGENCY: STATE	NPL STATUS: ACTIVE
HAS SITE BEEN PUT TO USE? YES		
WHO CONDUCTED THE REVIEW: US EPA REGION 4 & TN SUPERFUND STAFF		
NAME OF AUTHOR & AFFILIATION: FEMI AKINDELE, US EPA REGION 4		
SITE INSPECTION DATE: 3/25/2004		
REVIEW TYPE: STATUTORY	REVIEW #1	DUE DATE: 5/10/2004
TRIGGER ACTION/DATE: DATE RA CONTRACTOR MOBILIZED TO SITE-5/10/1999		
TRIGGER ACTION DATE: 5/10/99		

Issues & Recommendations:

1. Non-aqueous phase liquid has been found in certain monitoring wells recently. The waste should be recovered and disposed of appropriately. It is likely that additional liquid will drain into the monitoring wells in the future. Such waste should be recovered periodically and disposed of properly. A decision document such as an ESD would be required to describe the reason for such additional remedial work and the necessary funding.
2. Sample key monitoring wells quarterly instead of biannually as currently done. This will ensure that seasonal weather conditions are adequately accounted for relative to the measured contaminant concentrations. It will also ensure that actions are initiated without delay if site contaminants should migrate offsite at unacceptable levels.
3. Repair the damaged fence sections and remove debris caused by recent tornado.
4. Place fill dirt in low spots over the treated soil area and maintain grass coverage to ensure that precipitation continues to drain effectively.

Protectiveness Statements: The remedy implemented at this site currently protects human health and the environment based on the information evaluated in this report. It has eliminated exposure to soil contaminants and reduced contaminant run-off into the area surface water. In addition, it is controlling leaching of contaminants into the groundwater. If the recommendations made in this document are implemented properly, the remedy should remain protective in the long-term.

Approved by 
Winston A. Smith,
Director
Waste Management Division
US EPA Region 4

Date 7/21/04

**FIVE-YEAR REVIEW REPORT
AMERICAN CREOSOTE WORKS SUPERFUND SITE
JACKSON, TENNESSEE**

I. INTRODUCTION

The purpose of Five-Year Reviews is to determine if a remedy conducted at a site is protective of human health and the environment. Methods, findings, and conclusions of reviews are documented in Five-Year Reports. In addition, the reports identify issues found during the review, if any, and make recommendations to address them.

The Agency has prepared this Five-Year Review pursuant to CERCLA §121 and the National Contingency Plan (NCP). CERCLA §121 states:

“If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgement of the President that action is appropriate at such site in accordance with section 104 or 106, the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.”

The Agency interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii) states:

“If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.”

This document is the report of the first Five-Year Review of the Operable Unit 2 Remedial Action (OU2 RA) at the American Creosote Site, Jackson, Tennessee. Two previous Five-Year Reviews were conducted for the site in 1995 and 2000, respectively, to evaluate OU1 RA. The second OU1 Review report indicated that a separate Review of OU1 was no longer appropriate and that OU2 Reviews would address the entire site. Thus, the present document is the third Five-Year Review report for the site, but the first Five-Year Review since implementing the OU2 RA. Therefore, this Review evaluates the performance of all remedial activities conducted at the site to date.

II. SITE CHRONOLOGY

TABLE 1: CHRONOLOGY OF EVENTS

EVENT	DATE
State officials began enforcement action and site sampling	November 1981
NPDES permit issued to ACW by State	December 1981
ACW stopped wood preserving operations	December 1981
ACW went into Chapter 11 bankruptcy	May 1982
EPA conducted site reconnaissance	March 1983
EPA initiated sampling and emergency removal actions	May 1983
Site put on the NPL	1984
RI/FS conducted	1985-88
Record of Decision for OU1 issued	January 1989
OU1 Remedial Action conducted	Jan 1989 - Aug 1991
OU1 RA-Superfund-State Contract signed	May 1989
Support Agency Cooperative Agreement signed	April 1993
OU2 RI/FS conducted	March 1993-Sep 1996
First OU1 Five-Year Review	January 1995
OU2 ROD issued	September 1996
OU2 Treatability studies/RD conducted	Oct 96 - Sep 97
EPA approved and funded State-lead OU2 RA	Sep 1998
OU2 RA construction conducted	May 1999- May 2000
Construction Complete/Preliminary Close-out Report issued	May 2000
Groundwater monitoring began	June 2000
Second OU1 Five-Year Review	Sept 2000

III. BACKGROUND

Location

The American Creosote Works Site (ACW) is a 60-acre parcel of land located immediately southwest of downtown Jackson, in Madison, Tennessee. It is bounded on the south by the Seaboard Railroad, on the southwest by the south fork of the Forked Deer River, on the west and north by Central Creek, and on the east by an industrial yard.

Physical Characteristics

The general area is characterized by a gently rolling topography with marshy flood plains with a maximum relief of approximately 100 feet. Relief at the site is about 20 feet and the topography includes numerous swales, lagoons and other low lying areas. A few building structures remain at the site and it is surrounded by chain-link fencing.

Land and Natural Resource Use

Land in the area of the site is primarily used for industrial, commercial, and residential purposes. Natural resources include forests, pastures, surface water, groundwater, sand and clay. Although the area is wooded, the trees are small in size and do not appear to be of timber grade. Sand has been mined from all accessible geologic formations in the local area and extensive Wilcox clay mining has been conducted outside of the site.

The site is within an area drained by numerous major streams. Two of these, the South Fork of the Forked Deer River and the Central Creek, form the boundaries of the site. The South Fork of the Forked Deer River flows through Jackson, and is one of the principal rivers of the State. It was once used for steamboat travel and has a drainage area of 495 square miles.

History of Contamination

ACW was an abandoned 60-acre industrial facility which utilized creosote and pentachlorophenol (PCP) to preserve wood. The plant was operated from the early 1930s to December 1981, by the American Creosote Works, Inc., which went bankrupt in May 1982. Due to the bankruptcy, no potentially responsible parties have been involved in the remedial activities conducted at the site.

Between early 1930s and 1973, the plant discharged untreated process water on-site with minimal control and routinely polluted the Forked Deer River. In 1973, a levee was built around the facility to contain the wastewater and surface runoff. Between 1974 and 1975, the plant installed a wastewater treatment system and oil-water separators to control environmental pollution. Pits created during the construction of the levee were used to store treated process water and sludge, but the pits frequently overflowed during heavy rains, flooding the main

process area, and releasing waste into the river.

Enforcement actions began at the site in November 1981, when the State installed four monitoring wells around the property to assess the site's impact on the environment and its potential effect on human health. In December 1981, the facility was issued a National Pollution Discharge Elimination Systems Permit. In the same month, the plant closed down. The operator filed for bankruptcy protection under Chapter 11 in May 1982. During 1982 and 1983, the State conducted several inspections of the facility. All inspections resulted in citations for permit violations by the operator. Concurrently, the State collected environmental samples to evaluate the site and concluded that human health and the environment were at risk due to the prevailing conditions. In view of the facility's conditions and the operator's insolvency, the State requested the assistance of EPA's Region 4 emergency response group in June 1983.

In late 1983, EPA inspected the site and conducted environmental media sampling which confirmed the State's sampling results that the soil, surface water, sludge, and shallow sub-surface water were contaminated by creosote and PCP. This led to an immediate removal, treatment, and proper disposal of several thousand gallons of hazardous liquids and sludge at a cost of approximately \$735,000. The site inspection and sampling results were analyzed to rank the site for the National Priorities List in 1984.

Basis for Taking Action

In 1985, EPA approved an action memo to fund a Remedial Investigation/Feasibility Study (RI/FS) for the site. The RI/FS was conducted by the US Army Corps of Engineers under an Interagency Agreement with the EPA. Based on the results of the work, the decision was made to clean up the site in two phases or Operable Units (OUs).

Contaminants of concern included arsenic, dioxin, PCP, and polyaromatic hydrocarbons (PAHs). The site posed potential human health hazards and environmental threats primarily through incidental ingestion of site contaminants, dermal contact with contaminated soil, and/or inhalation of contaminated dust by trespassers and unprotected workers at the site. In addition, groundwater, surface water, and sediments from the site, which were contaminated with creosote and PCP, were transported offsite by various mechanisms, thereby posing a threat to human health and the environment outside the boundaries of the site.

IV. REMEDIAL ACTION

Remedy Description

The OUI Record of Decision (ROD), issued in January 1989, identified the following clean-up activities:

1. Deed restrictions to limit further use of the site

2. Construction of flood protection dike around the site and site stabilization.
3. Removal and disposal of tanked liquids and sludge.
4. Removal and disposal of site structures.
5. Installation of security fencing around the site.

The remedial requirements for OU1 were accomplished between January 1989 and August 1991, except that some of the site structures remained to be demolished and no deed restriction was filed. The flood protection levee was constructed and functional by early 1989. It was upgraded for improved effectiveness in 1990. Tanked liquids and sludge were accumulated, treated on-site and finally incinerated off-site. Several site structures, including buildings and tanks, railroad lines, railroad ties, and other plant equipment determined to constitute immediate hazards were demolished, dismantled and/or salvaged. Chain-link security fence was installed around the entire site in 1991.

OU1 activities focused on mitigating hazardous conditions at the plant process area, protecting the River, and preventing indiscriminate access to the site. Other problems and remedial activities related to contaminated soil and groundwater were deferred to future operable units. To maintain site surveillance during the period of planning for soil and groundwater remedial activities, Site Stabilization activities were provided for and funded through a Superfund-State Contract dated May 1989, and a Support Agency Cooperative Agreement dated April 1993. The Site Stabilization activities were conducted between 1993 and 1998, by the State. These included general site up-keep, maintenance of the flood prevention equipment, the perimeter fence, site grounds, erosion control, and lagoon water sampling.

Additional Remedial Investigation and Feasibility Studies were conducted at the site to evaluate its soil and groundwater contamination issues. The studies concluded that soil and water contamination was severe in several portions of the site and resulted in the decision to conduct a final remedy at the site. On September 30, 1996, EPA issued the OU2 ROD which concluded that the site would continue to be used as an industrial property. Therefore, industrial clean-up scenarios were found appropriate for the site. It also concluded that there was no evidence of groundwater contamination outside the boundaries of the site, but that the groundwater required a long-term monitoring program to ensure that its condition would not deteriorate with time. Therefore, the ROD specified a remedy which called for removal and offsite disposal of liquid waste, solidification/stabilization (S/S) of contaminated soil, deed restriction, and monitoring. The liquid recovery component was aimed at draining creosote and water from affected soil to enhance the effectiveness of the S/S. The liquid would be treated on-site before final disposal at EPA approved off-site facilities. The S/S phase would stabilize residual contaminants to limit their mobility, and solidify contaminated soil into a mass of treated waste with minimal disintegration potential. This would be achieved by excavating and mixing contaminated soils with appropriate chemical reagents such as Portland cement. The final product would be buried

in the excavated area, properly graded, and capped. The other requirements of the remedy were institutional control which would be reflected in the property deed limiting the site to industrial use, and a five-year sampling program to monitor contaminants in the groundwater, surface water, and sediment.

Industrial risk-based, soil remedial goals specified by the ROD in mg/kg (ppm) are : arsenic, 225; benzo (a)pyrene, 41.5; dibenzo(a,h)anthracene, 55; pentachlorophenol, 3,000; and dioxin, 0.00225. These clean-up goals were calculated to achieve the cancer risk protection level for future adult workers and were determined to be protective of current youth trespassers also.

While the ROD was under preparation, EPA's National Risk Management Research Laboratory (NRMRL) in Cincinnati, Ohio began to provide technical support for the site as requested by Region 4. In early 1996, NRMRL included the American Creosote Site in a national study of wood preserving waste treatment using solidification/stabilization (S/S) technologies. Science Applications International Corporation (SAIC) conducted the study for NRMRL. Contaminated soils were collected from three sites and three S/S vendors were chosen to treat the soils with several different chemical formulations. The results of the study indicated that soil contaminants associated with preserving wood by PCP, and creosote, could be immobilized effectively using S/S technologies.

To demonstrate successful application of the formulations, solidified products were subjected to leach tests, in addition to measurements of permeability and unconfined compressive strength (UCS). The following analytical results were obtained.

Arsenic	<50 ppb
Pentachlorophenol	<200 ppb
BAP potency	<10 ppb
Dibenzo(a,h)anthracene	<4.4 ppb
TCDD-TEQ	<30 ppq
Permeability	<1x10E-6 cm/sec
UCS (28 day cure)	>100 psi

In October 1996, NRMRL issued a follow-up Work Assignment (Contract No. 68-C5-0001, WA 1-20) to SAIC to conduct a site specific, S/S treatability study for ACW soils using various mixtures of Portland cement, fly ash, carbon, lime and/or kiln dust. The above laboratory results which were obtained from previous tests were specified as treatment goals for the site specific study. The study was completed in late 1996, and the results were reported including reagent mixtures, ratios, and associated costs for meeting the specified treatment goals.

EPA contracted with Bechtel to conduct a performance based remedial design for the site in early 1997. Under the contract, Bechtel reviewed pertinent site reports, acquired and evaluated a limited amount of new field data. The remedial design (RD), which was completed in September 1997, was prepared in accordance with the OU2 ROD and the S/S treatability study results. As

requested by EPA, Bechtel prepared the RD report in the format of a bid package which could be used easily as part of a request for proposal at a later date.

Remedy Implementation (OU2)

With the RD in place, and because the State's technical staff had been involved actively in the remedial activities conducted by EPA at the site, the Region believed that, with appropriate technical support from EPA, the State could take the lead for the remaining OU2 remedial activities. Therefore, EPA encouraged the State to consider conducting the remedial action. In August 1998, the State submitted a Fund-financed State-lead Cooperative Agreement for the work. EPA approved and funded the agreement for a total amount of \$6,000,000 in September 1988. This funding includes the State's ten percent cost-share.

The State prepared the OU2 RA scope of work and requested bids from several companies in early October, 1998. A pre-bid meeting, which was mandatory for all interested bidders, was held later in the month to discuss the RA requirements and to visit the site. EPA personnel from the Region and NRMRL attended the meeting to assist the State. Four companies submitted bids for the project at costs ranging from 2.8 to 12 million dollars, with OHM Remediation Services Corp. being the lowest bidder. A review of OHM's proposal and a meeting with the company's personnel by the State and EPA confirmed that the Company could perform the OU2 RA satisfactorily. Therefore, the State awarded the contract to OHM in March, 1999.

Remedial action construction began in May 1999. As part of the work, several site structures were demolished and removed from the site or broken-up, treated and buried on-site. Creosote and water were drained from the soil and disposed of at an EPA approved off-site location. Contaminated soil was excavated and treated with cement, carbon, and fly ash before back-filling and compacting. Buried materials were covered with a geosynthetic clay liner, and capped with twenty-four inches of clean fill. The final phase of the remedy construction was site grading and seeding with grass which were accomplished on May 11, 2000. The property is restricted by the County zoning ordinance to industrial uses only. In addition, EPA and the State have imposed land use restrictions on the property through their separate property acquisition agreements with JEA. These agreements became effective in June 2003 and February 2004 respectively.

A total of approximately 81,000 tons of contaminated soil from various parts of the site, 520,000 gallons of contaminated water and 16,000 gallons of creosote were processed during the OU2 RA. The treated soil was buried on-site, compacted and capped in an area of approximately seven acres. The cost of the OU2 Remedial Action to date is approximately \$3.5 million, including the S/S work and the on-going groundwater monitoring.

Summary of Last Five-Year Review

The present Five-Year Review is the first for the OU2 Remedial Action. However, two Five-Year Reviews were conducted for the OU1 remedy in 1995 and 2000. The reports for both

Reviews concluded that the activities conducted during the OU1 Remedial Action met their objectives. In addition, the report of the 2000 Review indicated that a separate Review of the OU1 remedy was no longer necessary, because the OU2 Five-Year Reviews would address the entire site. See Appendix A.

V. PROGRESS OF OU2 REMEDIAL ACTION

The soil cleanup at the site was documented in the OU2 Remedial Action Report and the Preliminary Close-Out Report prepared in 2000. Both documents indicated that the S/S was constructed satisfactorily. The RA report detailed the construction process and tests run to substantiate that the work was performed to meet the requirements of the ROD. As shown in Appendix B, excerpted from the RA report, confirmatory test results obtained during the S/S compared favorably with the specified clean-up goals. A copy of the Preliminary Close-Out Report with further information on the soil remediation is in Appendix C.

As stated previously, Long-term Monitoring was specified in the ROD as part of the OU2 RA to address groundwater cleanup. To date, the following field activities have been conducted to satisfy this requirement:

<u>Date</u>	<u>Activities</u>
May 2000	3 unserviceable monitoring wells abandoned, 4 new wells installed, 47 monitoring wells sampled
November 2000	Sampling of 20 monitoring wells
April 2001	Sampling of 32 monitoring wells
December 2001	Sampling of 18 monitoring wells
June 2002	Sampling of 26 monitoring wells and Geoprobe work
March 2003	Sampling of 18 monitoring wells

The purpose of the above monitoring activities is to evaluate the condition of the groundwater in the area relative to site contaminants after the S/S construction. Previous studies of the site showed that the aquifers underlying the property were contaminated by wood treatment compounds, but to an extent that did not require groundwater treatment. In addition, an extensive investigation of the groundwater outside the boundaries of the site concluded that the site did not pose a risk to human health or the environment. Therefore, the S/S conducted at the site was designed to prevent the deterioration of the aquifers by ensuring that site contaminants would not continue to leach appreciably into the groundwater. The current condition of the groundwater is evaluated on the basis of the data from the sampling activities which are detailed in Appendix D.

Analysis of the laboratory results in Table 3 of Appendix D shows that the main contaminants identified in the groundwater are three volatile organic compounds (VOCs), eleven polynuclear aromatic hydrocarbons (PAHs), and pentachlorophenol (PCP). Of the three VOCs, and the eleven PAHs, benzene and naphthalene are the most predominant, based on their frequency of occurrence and concentrations. Therefore, benzene, naphthalene, and PCP have been selected as the indicators of soluble contaminants in the following evaluation of current groundwater condition at the site. The historic detections of these three contaminants from the monitoring wells at the site have been obtained from Appendix D and presented below as Tables 2, 3, and 4, respectively.

Table 2-----Benzene Concentration History, ppb

Well #	June 2000	Dec 2000	May 2001	Jan 2002	July 2002	March 2003
2S	330	132	ND	<250	<50	10
2D	-	-	<1	<1	<1	<1
2M	20	26	ND	<250	<250	18
15	-	-	-	<100	<50	<1
16	140	-	ND	1500	100	120
17	140	-	ND	<250	-	18
19S	ND	-	-	<1	<1	<1
19M	ND	-	-	<1	<1	<1
20S	-	-	ND	<25	86	73
20M	-	-	ND	<25	<1	<1
Avg.on-site wells	158	79	<1	240	60	24
OSGW 4-2	-	-	7	<1	<1	<1
OSGW 4-3	-	.4	ND	<1	<1	-
OSGW 6-1	-	.4	-	-	-	-
OSGW 6-3	-	.4	-	-	-	-
Avg.off-site wells	-	.4	3.5	<1	<1	<1

Table 3— Naphthalene Concentration History, ppb

Well #	June 2000	Dec 2000	May 2001	Jan 2002	July 2002	March 2003
2S	2200	2500	2160	2400	890	150
2M	3100	129	2340	3000	3500	1200
2D	8	-	<10	<10	<10	<10
15	-	-	-	5300	1400	<10
16	4900	5550	7650	4800	2400	4700
17	4900	5550	-	3800	-	3100
19S	-	-	19	<10	<10	<10
19M	-	-	38	39	42	<10
20S	1600	1500	1990	1300	1900	3700
20M	2	-	10	33	<10	<10
Avg.on-site wells	2387	3046	1777	2069	1129	1290
OSGW 4-1	-	.6	ND	27	<10	<10
OSGW 4-2	-	.3	113	<10	<10	<10
Avg.offsite wells	-	0.5	56.5	18.5	<10	<10

Table 4—PCP Concentration History, ppb

Well #	June 2000	Dec 2000	May 2001	Jan 2002	July 2002	March 2003
2S	230	-	-	<200	<100	<10
2M	140	356	320	<200	<1000	100
2D	-	-	<10	<10	<10	<10
15	-	-	-	4000	<10	1200
16	5300	7420	-	5200	1300	3200
17	5300	7420	-	<1000	3100	
19S	-	-	-	<10	<10	<10
19M	360	115	-	29	<10	<10
20S	2400	8400	4950	3800	5800	4400
20M	69	-	-	22	<10	<10
Avg. on-site wells	1971	4742	1760	1447	1135	994
OSGW 4-2	-	NA	232	63	<10	<10

Although, between eighteen and forty-seven wells were sampled during the periodic groundwater monitoring events after the S/S construction, site contaminants were detected at elevated levels only in a maximum of fifteen wells. (See Tables 2-4). For the purpose of this review, the fifteen wells have been divided into three groups. Group 1 wells are those sampled to monitor the contaminant source areas. They include wells 15, 16, 17, 19S, 19M, 20S and 20M. Group 2 wells are located in the southwest portion of the site near the area where treated sludge was buried. They include wells 2S, 2M and 2D. Group 3 wells are located outside the boundaries of the site and are in the primary groundwater flow directions based on potentiometric mapping. They consist of wells OSGW 4-1, OSGW 4-2, OSGW 4-3, OSGW 6-1 and OSGW 6-3. With this distribution of monitoring wells, the groundwater sampling data presented above provide an adequate coverage of the site to measure the progress of the OU2 RA.

With the accomplishment of the S/S construction in 2000, site conditions have improved considerably. As stated before, several structures, equipment and debris remaining at the site after the OU1 activities were removed during the OU2 RA construction. The site was graded and

seeded with grass to complete the construction. However, when the site was inspected recently as part of this Review, a few low spots with standing water and bare areas were observed on the cap. These require additional fill dirt and re-seeding. A tornado went through the area on May 5, 2003, and damaged portions of the perimeter fence and one remaining building on-site. The fence needs to be repaired and the building demolished or secured.

Based on the confirmatory sampling results reported on the site after the S/S work, the property is clean and threat to human health due to direct contact with the surface soil has been eliminated. Recently, a local company, Jackson Energy Authority (JEA) acquired the property for use in light industrial operations. The same company leased a portion of the site in 1999, and has utilized it since then for equipment storage. JEA assumed responsibility for maintaining the property and compliance with its use restrictions as part of the acquisition agreement. The firm has initiated regrading activities outside the capped area of the site and has started utilizing the property for equipment storage.

The groundwater sampling data shown in Tables 2-4 indicate that wood treatment compounds from the site are present in the underlying aquifers. However, this condition has been known since the site was discovered and all clean-up decisions implemented at the site to date have been aimed at ensuring that the condition does not deteriorate. An extensive study of the site was conducted several years ago by the U.S. Geological Survey (USGS) to evaluate the hydro-geology, groundwater quality, and potential for water supply contamination near the site. The report of the USGS study was completed in 1993, and is attached as Appendix E.

USGS indicated that naphthalene was detected in the onsite samples from the shallow aquifer at concentrations ranging from 2 to 7,600 ppb. In the same samples, PCP concentrations ranged from 80 to 3,200 ppb and benzene concentrations ranged from 1 to 250 ppb. In comparison, naphthalene concentrations in the water samples from the shallow aquifer have ranged from 10 to 7650 ppb since the S/S was conducted in 2000. Concentrations of PCP have ranged between 10 and 8400 ppb, and benzene concentration values have ranged from 1 to 1500 ppb. Similar trends have been observed in the middle aquifer at the site.

Naphthalene concentrations do not appear to be different for the periods before and after 2000. In addition, a closer look at the benzene data in Table 2 reveals that the high concentration of 1500 ppb occurred only once, i. e. in January 2002, for well #16. It appears to be anomalous considering that the other thirty-five benzene detections were reported at a maximum of 330 ppb. If this lone 1500 ppb point were ignored, then benzene concentrations for well samples after the soil cleanup would range from 1 to 330 ppb. This order of magnitude in concentration range compares favorably with the benzene concentration range of 1 to 250 ppb reported for the samples before the 2000 S/S work. Based on these observations, there is no significant difference in the condition of on-site groundwater due to creosote contamination in the periods before and after the soil remediation. In any case, there has been no new source of soil contamination by creosote and the quantity of the compound in the originally contaminated soil is finite. Furthermore, contaminated soil has been treated successfully to minimize leaching as

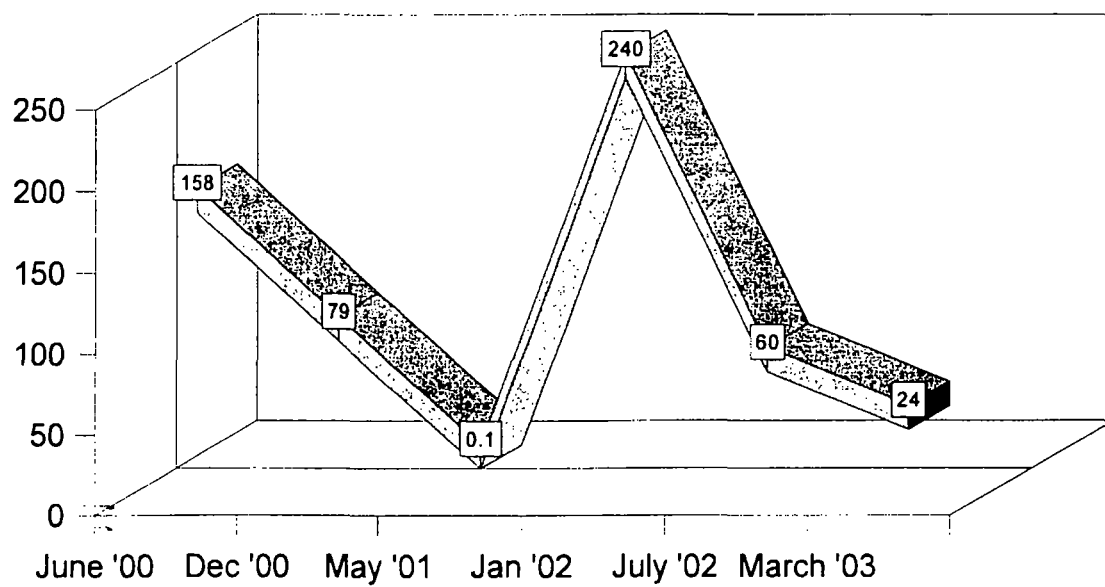
previously discussed and generally, creosote is prone to natural attenuation. Therefore, concentration of creosote in the groundwater is expected to decrease in the future.

A review of Table 4 indicates that high concentrations of PCP have been detected primarily from the monitoring wells located in previous hot spots. These are wells 15, 16, 17, and 20S. An increase in the range of PCP concentrations from these wells after the S/S construction relative to the range before suggests that additional PCP has been released into the groundwater from the soil since the USGS study was completed in 1993. As in the case of creosote, because there is a finite quantity of PCP originally in the contaminated soil and because the S/S was designed and constructed to minimize contaminant leachability, future concentrations of PCP in the groundwater should not exceed the current level.

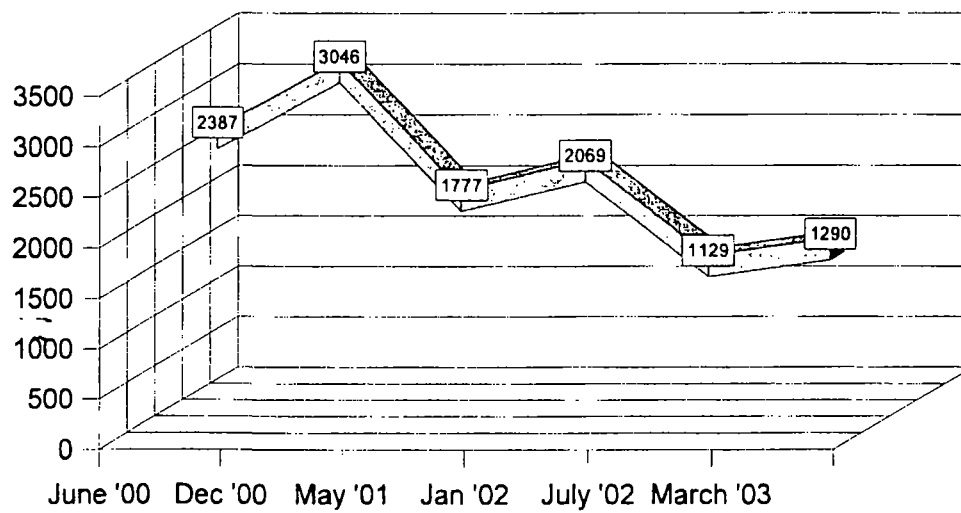
Averages of the contaminant concentrations in the on-site groundwater which are presented in Tables 2-4 are summarized in the table below and on the graphs that follow. As the graphs indicate, on the average, contaminant concentrations are declining. As stated before, because there is no new source of contamination at the site, the observed trends should continue.

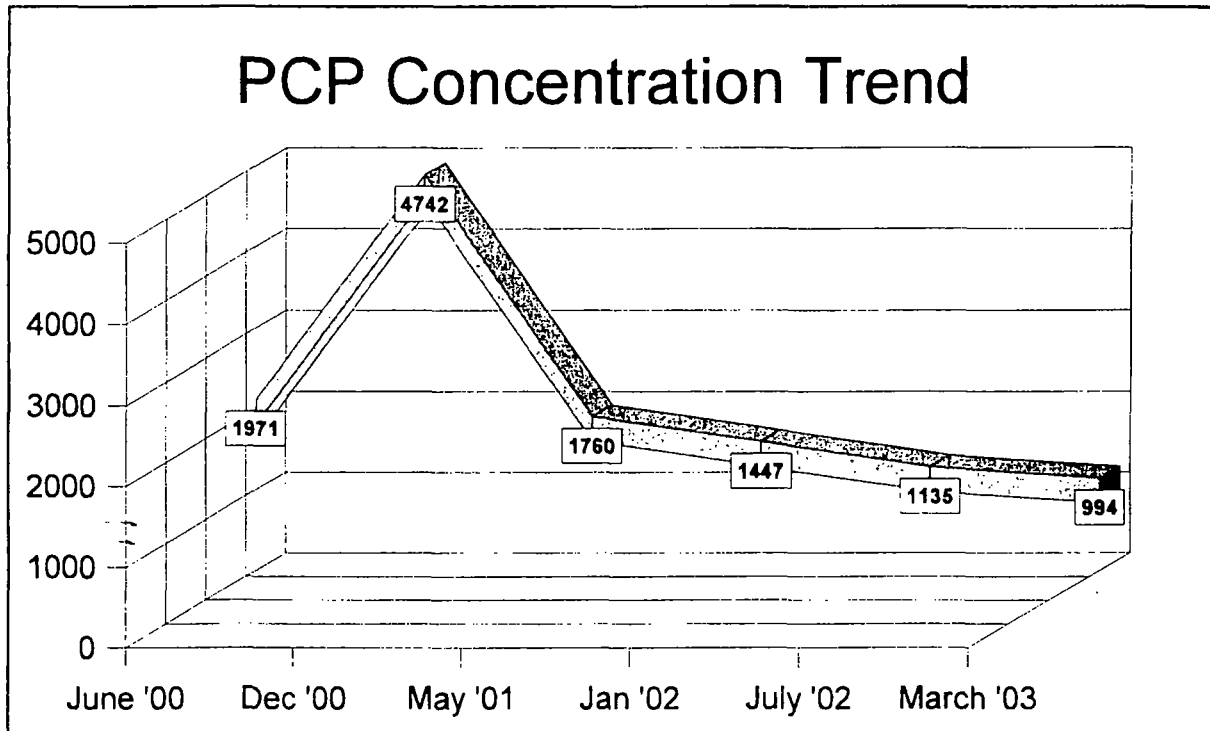
Sampling Date	Benzene, ppb	Naphthalene, ppb	PCP, ppb
June 2000	158	2387	1971
Dec 2000	79	3046	4742
May 2001	1	1777	1760
Jan 2002	240	2069	1447
July 2002	60	1129	1135
March 2003	24	1290	994

Benzene Concentration Trend



Naphthalene Concentration Trend





The USGS study (1993) found no PCP in the offsite water samples. However, it reported concentrations of naphthalene at 0.6-20 ppb and concentrations of benzene at 0.2-16 ppb. These compounds have been found primarily in the shallow aquifer after the soil remediation at concentrations of <10-232 ppb for PCP, 0.6-113 ppb for naphthalene, and 0.4-7 ppb for benzene. While the contaminant concentration ranges appear to be higher after the soil remediation than before, the higher limits occurred in samples taken in May 2001 only. After that sampling date, concentrations of the compounds have decreased steadily as indicated by the sampling data for OSGW wells 4-1, 4-2, 4-3, 6-1, and 6-3 in Tables 2-4. Therefore, the condition of the groundwater outside the boundaries of the site remain protected by the remedial activities conducted at the site to date.

Institutional Controls (IC) are a component of the OU2 RA. The main reasons for this component are:

1. To ensure that the site remains restricted from being used for residential purposes.
2. To prohibit the use of on-site groundwater for domestic purposes.
3. To protect the integrity of site remedy.

The following instruments will ensure that IC will be maintained at the site.

A. Madison County, Tennessee records indicate that the property is in "I-2" and "I-3" zoning segments which are permitted for Light Industrial and General Industrial uses respectively. Both specifically prohibit the use of the property for residential, retail, church, and school purposes.

B. The agreement between EPA and JEA executed in 2003 to release EPA's lien on the property explicitly requires JEA to refrain from activities that will adversely affect previous and future remedial measures at the site. JEA is also required to secure all government controls necessary to maintain land and water use restrictions at the site.

C. The Voluntary Agreement between the State and JEA requires JEA to file and maintain a Notice of Land Use Restrictions with the county. Filing of this document is pending at this time.

VI. FIVE-YEAR REVIEW PROCESS

Administrative Components

USEPA was the lead agency responsible for this Five-Year Review. EPA Region 4 and the State of Tennessee collaborated in conducting the Review. The primary personnel on the project were Mr. Femi Akindele (EPA Region 4, Atlanta Georgia) and Mr. Don Sprinkle (Tennessee Department of Environment and Conservation, Jackson, Tennessee).

Document and Data Review

For this report, the following site related documents were reviewed.

1. First and Second Five-Year Reviews for OU1.
2. Records of Decision (OU1-January, 1989; OU2-September, 1996)
3. USGS report, "Hydrogeology, Groundwater Quality, and Potential for Water-Supply Contamination near an Abandoned Wood-Preserving Plant Site at Jackson, Tennessee" (1993)
4. USGS report, "Water Quality, Organic Chemistry of Sediments, and Biological Conditions of Streams near an Abandoned Wood-Preserving Plant Site at Jackson, Tennessee" (1993)
5. Preliminary Close-Out Report (May 2000)
6. Remedial Action Report (June 2000)
7. Site Investigation Report prepared by ATC Associates for Tennessee State in February 2001.
8. Letter report dated February 9, 2004, from Shaw Environmental, Inc. to Tennessee Department of Environment and Conservation.
9. Historical Data Tables and Maps prepared by Shaw Environmental, Inc for the State in March 2004.
10. Final Remedial Investigation Report by S&ME Inc., July, 1988.
11. Final Feasibility Study Report by S&ME Inc., October, 1988.

ARARS Review

The applicable or relevant and appropriate requirements (ARARs) for site remedy listed in the ROD were reviewed in the process of preparing this report. Both Federal and State standards were considered as part of the remedy selection and the clean-up activities were found to be in compliance. No remedial activities conducted at the site to date have violated the ARARs and no modification of ARARs of any relevance to site activities appears to have occurred.

Ecological Issues

An ecological study was conducted in 1993 by the USGS to determine the effect of site contaminants on the nearby Central Creek and the South Fork of the Forked Deer River. The study concluded that PCP and creosote constituents were detected in the creek and the river at

concentrations that would adversely affect the population and diversity of fish and aquatic life. Furthermore, it was reported that low levels of site related contaminants were detected in fish tissues. The USGS indicated that surface run-off and groundwater from the site caused most of the deterioration of the surface water and sediments sampled. Due to the construction of the OU2 RA, run-off from the site should contain a minimal amount of PCP and creosote at this time. As required by the OU2 ROD, surface water and sediments are in the process of being sampled to evaluate the current condition of the creek and the river.

Site Inspection

Tennessee, as the lead agency for site activities, inspects the site regularly and reports its condition to EPA as necessary. EPA also visits the site from time to time. Both agencies conducted a joint inspection of the site as part of this Five-Year Review on March 25, 2004. The deficiencies observed included the fencing damage and debris caused by a recent tornado in the area, low spots on the cap, and areas requiring re-seeding. These require repairs but pose no immediate concern relative to the effectiveness of site remedies. Overall, the site was in good physical condition and was already being re-used by the recent purchaser, JEA.

Community Involvement Activities

On March 17, 2004, EPA announced in the local newspaper (The Jackson Sun) that this Five-Year Review was under preparation and invited comments from the public on the site. An EPA's Public Affairs Specialist (Ms. Linda Starks) conducted interviews with area residents and officials regarding site activities during the period of this Five-Year Review.

She reported that one area resident was concerned about the benzene found in recent water samples from the site and that the contaminant might be hazardous to wildlife and consumers of fish caught from the nearby Forked Deer River. The State Project Manager for the site apparently spoke with the resident and allayed her fears.

Another area resident commented that his private water well was sampled ten years ago by EPA and was found to be free of site contaminants. However, he is concerned that since then, no follow-up sampling has been conducted on the well which he uses for potable water. EPA personnel discussed the resident's concern with the State Superfund Sites supervisor for the Jackson area who remembered speaking with the resident about this matter in the past. He thought the resident was satisfied with the explanation that his well was 2-3 miles away from the site and was too far to be affected by site contaminants. He indicated that he would speak again with the resident about his concerns.

Although EPA and the State have made public participation opportunities available frequently, response from the public at this site has been limited historically. There have been no public comments of any consequence on past or current site activities.

VII. TECHNICAL ASSESSMENT

Question A: Is the OU2 remedy functioning as intended by the decision documents?

The remedy implemented at the site was designed and constructed to meet the requirements of the OU2 ROD. Confirmatory sampling conducted during and after the S/S field work substantiated that the OU2 cleanup goals were met. Groundwater sampling data collected over the last five years were evaluated as part of this Review and discussed above. Based on all sampling data evaluated, the OU2 remedy is functioning as intended.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

The OU2 remedial action objective was primarily to cleanup the site to an industrial use standard. Appropriate exposure assumptions, and toxicity data were used to establish the proper cleanup levels for this land use scenario as detailed in the FS and the OU2 ROD. Site cleanup levels were achieved and substantiated as stated in the OU2 RA report. In addition, institutional controls exist on the property which restrict the site to industrial uses only as discussed before. Recently, the property has been acquired and is being used currently for light industrial operations. The parameters referred to in this question guided the clean-up and remain valid.

Question C: Has any other information come to light that could call the protectiveness of the remedy into question?

The primary aim of the OU2 remedy was to ensure that site soil was cleaned up to ensure that contact with the soil under industrial use would be safe. In addition, the remedy was intended to protect the groundwater from contaminants entering the groundwater due to precipitation. Monitoring of the groundwater is part of the remedy. Its intent is to ensure that site contaminants do not affect the groundwater and cause health or environmental issues offsite without a timely and appropriate action. Periodic sampling of the groundwater is conducted as discussed previously and the results are regularly evaluated to determine if any additional action is warranted. No information has come to light that could call the protectiveness of the OU2 remedy into question.

Technical Assessment Summary

Based on the information and data evaluated for this Five-Year Review, the OU2 remedy was designed and implemented to meet the requirements of the OU2 ROD. The site cleanup conducted has eliminated the human health and environmental hazards which, otherwise, would render the property un-reusable. The property has been recently purchased and is being used for industrial activities.

Groundwater sampling activities which are part of the OU2 remedy have shown that creosote and

PCP remain in the groundwater within the site boundaries at above background levels. The bulk of the groundwater contamination most likely occurred before the S/S construction. This is believed to be the case for the following two reasons: (1) Contaminant sources were mainly in the soil which was treated in 2000 to a high leach control standard. (2) Contaminant concentrations after the S/S, or over the last five years, have been erratic but, on the average for the site, exhibit declining trends. Therefore, on-site groundwater is believed to be protected by the OU2 RA. In any case, the property is precluded from being used for residential purposes by institutional controls. Hence, no domestic wells are expected to penetrate the aquifer in the future.

Groundwater outside the site indicated elevated concentrations of site contaminants after the S/S. Again, the pollution probably occurred before the S/S was conducted in 2000 because concentrations of the contaminants which were significant in May 2001 samples have steadily decreased as measured in the samples collected since then. Contaminant concentrations are expected to continue decreasing as they have been for the past three years because of the substantial reduction of pollution source by the OU2 remedy and the potential effect of natural attenuation.

VIII. ISSUES

1. Non-Aqueous Phase Liquid (NAPL) has been found in several on-site monitoring wells recently. Liquid contaminant recovery which was part of the OU2 field work succeeded in draining the NAPL partially. However, periodic recovery of residual liquid waste appears necessary.
2. Damage to the perimeter fencing caused by the recent tornado in the area has left the site easily accessible. This could encourage trespassing and expose the public to hazards especially from loosely hanging debris resulting from damaged structure on-site. Fence repairs and removal of the debris are considered part of the site maintenance which JEA is responsible for as stated in the property purchase agreements with EPA and the State.
3. Low spots and bare areas observed on the treated and capped soil are likely to deteriorate and reduce effective drainage of precipitation if not addressed immediately. This site maintenance issue is also JEA's responsibility.

IX. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

1. Continue to monitor the groundwater. Based on past sampling results, there are ten key on-site monitoring wells which should be sampled quarterly to ensure that the effects of changes in season are accounted for in future analyses of contaminant concentration trends. They include monitoring wells 2S, 2M, 2S, 15, 16, 17, 19S, 19M, 20S, and 20M which are located to monitor the buried sludge area and the previous contaminant source areas. In addition, maintain quarterly monitoring of off-site wells, especially wells OSGW 4-1, OSGW 4-2, OSGW 4-3, OSGW 6-1

and OSGW 6-3, which are located in the primary directions of groundwater flow. This will ensure that action is initiated without delay if site contaminants should begin to migrate offsite significantly.

2. Remove liquid waste from the affected monitoring wells by pumping and properly dispose of at an approved offsite facility. This is necessary to ensure continued protection of the groundwater and is considered a continuation of the liquid recovery work specified in the OU2 ROD. Ensure that wells affected in the future are unloaded and the waste disposed of appropriately.

3. JEA should repair the damaged fence sections to secure the site and remove the debris caused by the recent tornado.

4. Place fill dirt in low spots on the cap and seed for grass to maintain the effective drainage of precipitation. This is part of the site maintenance activities which are JEA's responsibility.

The State will implement these recommendations under the existing Superfund-State Cooperative Agreement for the OU2 RA. EPA will continue to provide technical support as necessary and ensure that the follow-up actions are accomplished in a timely manner.

X. PROTECTIVENESS STATEMENT

The remedy implemented at the site currently protects human health and the environment. It has eliminated exposure to soil contaminants. It has considerably reduced leaching of contaminants into the groundwater and contaminant run-off into the local surface water. Groundwater monitoring which is part of the remedy at the site continues to provide appropriate data to ensure that the groundwater is protected. If the recommendations listed above are implemented properly, the remedy is expected to be protective in the long-term.

XI. NEXT FIVE-YEAR REVIEW

The next Five-Year Review for this site is due in June 2009.

APPENDIX A

**OU1 FIVE-YEAR REVIEW #2
AMERICAN CREOSOTE WORKS SITE
JACKSON, TENNESSEE**

EPA Five-Year Review Signature Cover

Key Review Information

Site Identification		
Site name: AMERICAN CREOSOTE WORKS		EPA ID:TND007018799
Region: 4	State: TN	City/County: JACKSON, TN
Site Status		
NPL status: FINAL		
Remediation status: FINAL		
Multiple Operable Units: YES		
Construction completion date: 9/20/93		
Fund/PRP/Federal facility lead: FUND	Lead agency: EPA REGION 4	
Has site been put into reuse?: YES (partially)		
Review Status		
Who conducted the review (EPA Region, State, Federal agency):EPA-Region 4		
Author name: FEMI AKINDELE	Author title: PROJECT MANAGER	
Author affiliation: U.S. EPA Region 4		
Review period:1995-2000		Date(s) of site inspection:1995-2000
Highlight: Statutory	Policy Type (name): 1. Pre-SARA 2. Ongoing 3. Removal only 4. Regional Discretion	Review number: 2
Triggering action event: First Five-Year Review Date		
Trigger action date: 1/25/95		
Due date: 9/30/00		

Deficiencies:

None

Recommendations and Required Actions:

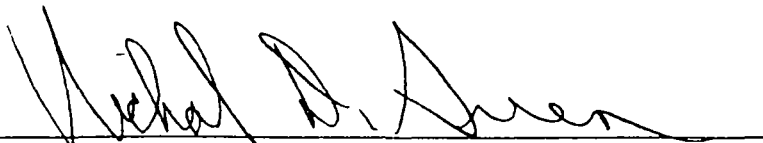
1. File deed restriction as required by ROD
2. Continue site monitoring and maintenance
3. Combine future OU1 five- year review with OU2 five-year review starting from 2004.

Protectiveness Statement(s):

The remedy at the AMERICAN CREOSOTE WORKS SITE (JACKSON) OU1 which was reviewed in this report is protective of human health and the environment. The OU2 RA conducted in 1999/2000 completed site cleanup and greatly enhanced OU1 remedy. Use of site must be limited to industrial/commercial purposes to protect the integrity of stabilization/solidification conducted at the site under the OU2 remedy as treated waste was backfilled on-site and properly capped.

Other Comments:

Future review of OU1 remedy will be adequately covered by OU2 remedy review. Therefore, no separate five-year review need be conducted henceforth. First OU2 remedy review will be conducted by May 2004.

Signature of EPA Regional Administrator or Division Director and Date

Signature

28 SEP 00

Date

Richard D. Green, Division Director
Name and Title

**SECOND FIVE-YEAR REVIEW REPORT
AMERICAN CREOSOTE WORKS SUPERFUND SITE
JACKSON, TENNESSEE
SEPTEMBER 26, 2000**

1.0 INTRODUCTION

Section 300.430(f)(4)(ii) of the National Oil and hazardous Substances Pollution Contingency Plan (NCP), 40CFR Part 300, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires five-year reviews of a remedial action that results in hazardous substances, pollutants, or contaminants remaining at a site above levels that allow for unlimited use and unrestricted exposure. The statutory reviews must continue, at least, every five years until contaminant levels allow for unlimited use and unrestricted exposure.

This document is the second five-year review of the Operable Unit One Remedial Action (OU1 RA) at the American Creosote Site, Jackson, Tennessee. The RA construction was initiated in July 1989, and completed in early 1990. The first five-year review was reported in January 1995.

1.1 SITE LOCATION

The American Creosote Works Site (ACW) is located immediately southwest of downtown Jackson, Tennessee, in an area used predominantly for industrial purposes. It is bounded on the south by the Seaboard Railroad, on the southwest by the south fork of the Forked Deer River, on the west and north by Central Creek, and on the east by an industrial yard. Jackson has a population of more than 60,000 people. Several public and private wells are located within a 3-mile radius of the site, including a city well field. Wetlands along the river support a large variety of wildlife.

1.2 SITE HISTORY

ACW is an abandoned 60-acre facility which utilized creosote and pentachlorophenol (PCP) to preserve wood. The plant was operated from the early 1930s to December 1981, by the American Creosote Works, Inc., which went bankrupt in May 1982. Due to the bankruptcy, no potentially responsible parties have been involved in the remedial activities conducted at the site to date.

Between early 1930s and 1973, the plant apparently discharged untreated process water on-site with minimal control and routinely polluted the Forked Deer River. In 1973, a levee was built around the facility to contain the wastewater and surface runoff. Between 1974 and 1975, the

plant installed a wastewater treatment system and oil-water separators to control environmental pollution. Pits created during the construction of the levee were used to store treated process water and sludge but the pits frequently overflowed during heavy rains, flooding the main process area, and releasing waste into the river.

Contaminants of concern at the site included arsenic, dioxin, PCP, and polyaromatic hydrocarbons (PAHs). The site posed potential human health hazards and environmental threats primarily through incidental ingestion of site contaminants, dermal contact with contaminated soil, and/or inhalation of contaminated dust by trespassers and unprotected workers at the site. In addition, groundwater, surface water, and sediments from the site, which were contaminated with creosote and PCP, were transported offsite by various mechanisms, thereby posing a threat to human health and the environment outside the boundaries of the site.

Enforcement actions began at the site in November 1981, when the State installed four monitoring wells around the property. In December 1981, the facility was issued a National Pollution Discharge Elimination Systems Permit. In the same month, the plant closed down. The operator filed for bankruptcy protection under Chapter 11 in May 1982. During 1982 and 1983, the State conducted several inspections of the facility. All inspections resulted in citations for permit violations by the operator. Concurrently, the State collected environmental samples to evaluate the site and concluded that human health and the environment were at risk due to the prevailing conditions. Based on the facility's conditions and insolvency of the operator, the State requested emergency response from EPA in June 1983. Ranking of the site for the National Priorities List (NPL) was completed in September 1984, and actual listing occurred in the following month.

EPA has conducted a series of clean-up activities at American Creosote Site since 1983. The activities have included emergency removal, treatment and disposal of hazardous waste, pollution control, environmental sampling, laboratory analyses, remedial investigations and feasibility studies, and stabilization/solidification of contaminated soil. Initially, EPA inspected the site and conducted field sampling which confirmed that soils, surface water, sludge, and shallow sub-surface water were contaminated by creosote and PCP. This led to an immediate removal, treatment, and proper disposal of several thousand gallons of hazardous liquids and sludge.

In late 1985, EPA approved an action memo to fund a Remedial Investigation/Feasibility Study (RI/FS) for the site. The RI/FS was conducted by the US Army Corps of Engineers. Based on the results of the work, a Record of Decision (ROD) was published in January 1989. The ROD outlined plans for cleaning the site in phases (operable units), and identified the tasks for Operable Unit 1 (OU1) as follows:

1. Deed restrictions to limit further use of the site
2. Construction of flood protection dike around the site and site stabilization.
3. Removal and disposal of tanked liquids and sludge.

4. Removal and disposal of site structures.
5. Installation of security fencing around the site.

The remedial requirements for OU1 were accomplished between January 1989 and August 1991, except that some of the site structures remained to be demolished and no deed restriction was filed. The flood protection levee was constructed and functional by early 1989. It was upgraded for improved effectiveness in 1990. Tanked liquids and sludge were accumulated, treated on-site and finally incinerated off-site. Several site structures, including buildings and tanks, railroad lines, railroad ties, and other plant equipment determined to constitute immediate hazards were demolished, dismantled and/or salvaged. Chain-link security fence was installed around the entire site in 1991.

OU1 activities focused on mitigating hazardous conditions at the plant process area, protecting the river, and preventing indiscriminate access to the site. Other problems and remedial activities related to contaminated soil and groundwater at the site were deferred to future operable units. To maintain site surveillance during the period of planning for soil and groundwater remedial activities, Site Stabilization activities were provided for and funded through a Superfund-State Contract dated May 1989, and a Support Agency Cooperative Agreement dated April 1993. The Site Stabilization activities were conducted between 1993, and 1998, by the State and included general site up-keep, maintenance of flood prevention facility, the perimeter fence, site grounds, erosion control, and lagoon water sampling.

1.3 SUMMARY OF PREVIOUS FIVE-YEAR REVIEW

An evaluation of the OU1 remedial action was reported in the first Five-Year Review dated January 25, 1995. According to the report, the OU1 remedial tasks that were accomplished are permanent and generally effective. Tanked liquids, sludge, and site structures removed and disposed of no longer pose threats to human health or the environment. The security fence around the site effectively prevents unauthorized entry. However, the review noted that other structures remained to be removed from the site and the deed restrictions to limit further use of the site as required by the OU1 ROD was pending. In addition, there were operational problems with the flood control levee and equipment which needed to be resolved. The pump installed as part of the remedial action to remove and discharge water from the site to the river during heavy rains and flooding malfunctioned frequently. Consequently, water accumulated on top of the stabilized sludge which was buried on-site. Other than the unfavorable observation that some areas of the site inside and outside the fence which were required to be cleared under the Site Stabilization Cooperative Agreement were overgrown, the first five-year review indicated that site maintenance was satisfactory. The review concluded by recommending that the Site Stabilization activities be continued as planned through April 1998, and anticipated further remedial actions at the site.

1.4 PROGRESS SINCE THE LAST REVIEW

Since the last review, additional remedial investigation was completed which resulted in the decision to conduct a final remedy at the site under a second operable unit (OU2). The OU2 ROD was issued in September 1996. The remedy selected in the ROD was based on industrial clean-up scenario. It called for removal and offsite disposal of creosote and contaminated water from the soil, solidification and on-site burial of contaminated soil, deed restriction, and site monitoring, including groundwater, for five years. The remedial action was conducted between May 1999, and May 2000. As part of the work, several site structures were demolished and removed from the site or disintegrated and buried on-site. Creosote and water were drained from the soil. Contaminated soil was excavated and treated with cement, carbon, and fly ash before back-filling and compacting. Buried materials were covered with geosynthetic clay liner, and capped with twenty-four inches of dirt. The site was then graded and seeded with grass. In effect, this remedial action included and accomplished the necessary site structure removal which the OU1 work did not complete. In addition, the OU2 remedy required deed restriction and site monitoring which OU1 called for also.

Several unsuccessful attempts were made by the State to repair the malfunctioning pump which was installed as part of OU1 remedy to control flood water at the site. To improve the condition, the State abandoned the pump in 1998, and cut the levy to allow water to flow freely to the nearby Central Creek instead of accumulating on-site during heavy rains and flooding. This proved to be more effective for flood control than the pump which was unreliable. As stated above, part of the OU2 remedial action work completed in May 2000, was site grading which was designed to enhance flood control at the site also.

1.5 ARARS REVIEW

The applicable or relevant and appropriate requirements (ARARs) for the OU1 remedy as listed in the OU1 ROD were reviewed relative to this report. Both federal and state standards were considered as part of the remedy selection. No activities conducted to date under the Operable Unit have modified the ARARs.

2.0 CURRENT SITE CONDITIONS

With the completion of OU2 remedial construction, conditions at this site have improved significantly since the last review. As stated before, remaining structures, equipment and debris requiring removal after the OU1 activities were removed during the OU2 construction. The site was graded and seeded with grass. Surface soil is clean and threat to human health due to direct contact with the soil has been eliminated. Recently, a local company expressed interest in acquiring the property for light industrial use, indicating that it is considered valuable. In summary, current site conditions are satisfactory aesthetically and environmentally.

3.0 CONCLUSIONS

The goal of the OU1 remedial action was to mitigate hazardous conditions at the site, particularly the plant process area, protect the nearby river, and prevent unrestricted access to the site. The previous five-year review concluded that the remedial action was permanent and effective with the exception of the flood control pump that broke down frequently. The current review has identified substantial improvement in the site conditions due to changes made in the flood control strategy, and OU1 remedy enhancement by virtue of OU2 activities. Therefore, the goal of the OU1 remedial action has been accomplished. The remedy remains permanent, functional and should be effective indefinitely.

4.0 RECOMMENDATIONS

Some uncompleted tasks of the OU1 remedy were identified in this review. They are the deed restriction requirement, site maintenance (grass cutting, fence/gates, grounds, etc), and surface water monitoring. These tasks are also part of the OU2 remedial activities. Due to the overlap, it is recommended that they are conducted under OU2 and removed from OU1 requirements. In addition, no further five-year reviews need be conducted for OU1 remedial action because the five-year reviews for OU2 remedy, the first of which is due four years from now, will adequately address the effectiveness of all ACW clean-up activities.

5.0 PROTECTIVENESS STATEMENT

The OU1 remedial activities at this site included removal and proper disposal of creosote and other tanked sources of contamination, treatment and burial of solidified sludge, construction of flood protection dike around the site, removal and disposal of contaminated structures, and installation of security fencing. These activities reduced human exposure to hazardous materials at the site considerably. Subsequent remedial action conducted under OU2 was designed to eliminate other risks of human exposure considering industrial scenario. Therefore, the site is protective of human health under controlled use.

6.0 NEXT FIVE-YEAR REVIEW

No further five-year review of the OU1 remedial action is deemed necessary. Five-year reviews of the OU2 remedial action, the first of which is due by May 2004, are expected to address all remedial activities at the site.

APPENDIX B

**SOLIDIFICATION/STABILIZATION TEST RESULTS
AMERICAN CREOSOTE WORKS SITE
JACKSON, TENNESSEE**

3/30/00

**American Creosote Works Site
Quantity Summary Sheet**

ITEMS		QUANTITIES
Treated Material		80,693 TONS
Process Area Excavation		32,812 CY
Drip Track, Buffer Zones, HAB Areas Excavation		13,429 CY
Treated Water Discharged From Site		520,430 GAL
Soil Delivery		
Cap		18,732 CY
Drip Track		3,682 CY
North Utility Area		4,074 CY
Cutoff Wall / Holding Pond		3,920 CY
Topsoil		8,932 CY
Capped Area		304,448 SF
Debris Disposal (41 Loads)		858 CY

OHM/IT PROJECT NUMBER 781433
JACKSON, TENNESSEE
TREATED SOIL SAMPLE RESULTS AS OF
1/10/00

SAMPLE NUMBER	DATE SAMPLED	TREATED TONS	CUMULATIVE TONS	UCS - 7 psi	UCS - 28 psi	PERMEABILITY cm/second	ARSENIC mg/L	BENZO(a) PYRENE (ug/L)	DIBENZO(a,h) ANTHRACENE (ug/L)	PENTACHLORO- PHENOL (ug/L)	DIOXINS (TEQ) pg/L	COMMENTS
TREATMENT GOAL/ALLOWABLE												
TS-001	6/10/99	N/A		N/A	>100/80	<1x10 ⁻⁶ /1x10 ⁻³	<50/75	<10/15	<4.4/6.6	<200/300	<30/45	
TS-002	6/10/99	N/A										Treat Sample
TS-003	7/26/99	225.25	225.25	64.0	82.2	4.1 X 10 ⁻⁷	<0.0020	<0.5	<0.4	15	0.0	
TS-004	7/27/99	546.14	771.39	127.0	N/A	6.0 X 10 ⁻⁷	<0.0020	<0.5	<0.4	26	0.0	
TS-005	7/28/99	331.99	1,103.38	146.0	N/A	1.0 X 10 ⁻⁶	<0.0020	<0.5	<0.4	4.6	0.1	
TS-006	7/29/99	162.14	1,265.52	300.0	N/A	2.4 X 10 ⁻⁷	<0.0020	<0.5	<0.4	4.9	0.0	
TS-007	8/2/99	366.40	1,631.92	165.0	N/A	6.5 X 10 ⁻⁷	0.0031	<0.5	<0.4	92	0.1	
TS-008	8/3/99	559.33	2,191.25	187.0	N/A	4.3 X 10 ⁻⁷	<0.0020	<0.5	<0.4	610/560	0.2	
TS-009	8/4/99	800.75	2,992.00	211.5	N/A	1.6 X 10 ⁻⁵	0.0038	<1.0	<0.8	2100/1300	0.2	
TS-010	8/5/99	773.04	3,765.04	145.5	N/A	1.2 X 10 ⁻⁵	0.0031	<1.0	<0.8	790/550	0.2	
TS-011	8/9/99	750.00	4,515.04	173.9	N/A	2.4 X 10 ⁻⁷	<0.0020	<0.5	<0.4	140	42.6	
TS-012	8/9/99	167.38	4,682.42	28.0	35	5.8 X 10 ⁻⁶	0.0043	<0.5	<0.4	88	16.6	2nd batch
DTS-012	8/9/99	N/A	4,682.42	N/A	N/A	N/A	0.0042	<0.5	<0.4	150	8.2	QC Duplicate
TS-013	8/10/99	496.28	5,178.70	158.0	N/A	4.9 X 10 ⁻⁶	<0.0020	<0.5	<0.4	89	8.8	
TS-014	8/11/99	724.89	5,903.59	101.0	N/A	1.4 X 10 ⁻⁶	0.0030	<5.0	<4.0	75	31.7	
DTS-014	8/11/99	N/A	5,903.59	152.5	N/A	5.0 X 10 ⁻⁵	N/A	N/A	N/A	N/A	N/A	Phys test Dup
TS-015	8/12/99	451.35	6,354.94	160.0	N/A	4.7 X 10 ⁻⁷	0.0040	<5.0	<4.0	520/540	39.0	
---	8/13/99	69.50	6,424.44	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Incl w/TS-015
TS-016	8/24/99	595.18	7,019.62	205.5	N/A	9.6 X 10 ⁻⁷	<0.0020	<0.5	<0.8	90	0.0	2% C @ 120tph
TS-017	8/25/99	805.80	7,825.42	97.7	N/A	2.6 X 10 ⁻⁶	0.0027	<0.5	<0.4	120	0.1	2% C @ 120tph
TS-018	8/26/99	394.30	8,219.72	201.4	N/A	1.7 X 10 ⁻⁶	0.0057	<2.5	<2.0	74	5.4	2% C @ 120tph
TS-019	8/27/99	348.44	8,568.16	215.0	N/A	1.6 X 10 ⁻⁵	0.0043	<1.0	<0.8	370/380	0.0	2% C @ 120tph
TS-020	8/30/99	750.00	9,318.16	160.0	N/A	7.2 X 10 ⁻⁸	<0.0020	<1.0	<0.8	4.9	0.0	2% C @ 120tph
TS-021	8/30/99	453.28	9,771.44	102.2	N/A	1.6 X 10 ⁻⁵	<0.0020	<1.0	<0.8	7	1.9	2% C @ 120tph
TS-022	8/31/99	750.00	10,521.44	224.1	N/A	6.3 X 10 ⁻⁸	<0.0020	<1.0	<0.8	26	0.0	2% C @ 120tph
DTS-022	8/31/99	N/A	10,521.44	125.0	N/A	2.3 X 10 ⁻⁵	<0.0020	<1.0	<0.8	26	0.0	QC Duplicate
TS-023	8/31/99	251.38	10,772.82	252.5	N/A	1.6 X 10 ⁻⁶	<0.0020	<1.0	<0.8	<2.2	0.0	2% C @ 120tph
TS-024	9/1/99	750.00	11,522.82	129.0	N/A	1.6 X 10 ⁻⁵	0.0023	<1.0	<0.8	19	0.2	2% C @ 120tph
TS-025	9/1/99	409.33	11,932.15	117.0	N/A	7.8 X 10 ⁻⁶	<0.0020	<1.0	<0.8	25	0.3	2% C @ 120tph
TS-026	9/2/99	750.00	12,682.15	94.5	N/A	1.2 X 10 ⁻⁵	<0.0028	<1.0	<0.8	30	0.2	2% C @ 120tph

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1/10/00

SAMPLE NUMBER 781433-	DATE SAMPLED	TREATED TONS	CUMULATIVE TONS	UCS - 7 psi	UCS - 28 psi	PERMEABILITY cm/second	ARSENIC mg/L	BENZO(a) PYRENE (ug/L)	DIBENZO(a,h) ANTHRACENE (ug/L)	PENTACHLORO- PHENOL (ug/L)	DIOXINS (TEQ) pg/L	COMMENTS
TREATMENT GOAL/ALLOWABLE												
TS-027	9/2/99	354.87	13,037.02	210.2	N/A	1.7×10^{-6}	0.0029	<1.0	<0.8	5.5	0.2	2% C @ 120lph
TS-028	9/3/99	539.76	13,576.78	249.0	N/A	2.0×10^{-7}	<0.0020	<1.0	<0.8	24	0.3	2% C @ 120lph
TS-029	9/7/99	750.00	14,326.78	207.5	N/A	1.2×10^{-5}	<0.0020	<1.0	<0.8	62	0.0	2% C @ 120lph
TS-030	9/7/99	252.41	14,579.19	202.6	N/A	7.5×10^{-6}	0.0023	<1.0	<0.8	40	0.0	2% C @ 120lph
TS-031	9/8/99	750.00	15,329.19	182.0	N/A	8.1×10^{-6}	<0.0020	<1.0	<0.8	14	0.0	2% C @ 140lph
TS-032	9/8/99	480.54	15,809.73	146.0	N/A	1.9×10^{-6}	<0.0020	<1.0	<0.8	12	0.0	2% C @ 140lph
DTS-032	9/8/99	N/A	15,809.73	210.0	N/A	3.3×10^{-6}	<0.0020	<1.0	<0.8	9.7	0.0	2% C @ 140lph
TS-033	9/9/99	750.00	16,559.73	145.0	N/A	2.6×10^{-6}	0.0028	<1.0	<0.8	82	0.1	2% C @ 140lph
TS-034	9/9/99	258.01	16,817.74	112.0	N/A	6.7×10^{-6}	<0.0020	<1.0	<0.8	40	0.0	2% C @ 140lph
TS-035	9/10/99	804.49	17,622.23	195.0	N/A	1.3×10^{-7}	<0.0020	<1.0	<0.8	15	0.0	2% C @ 140lph
TS-036	9/13/99	750.00	18,372.23	148.0	N/A	2.6×10^{-7}	0.0037	<1.0	<0.8	3.2	0.0	2% C @ 140lph
TS-037	9/13/99	504.02	18,876.25	365.0	N/A	1.4×10^{-7}	0.0025	<1.0	<0.8	<2.2	0.0	2% C @ 140lph
TS-038	9/14/99	750.00	19,626.25	170.0	N/A	1.4×10^{-7}	0.0039	<1.1	<0.8	3.2	0.0	2% C @ 140lph
TS-039	9/14/99	377.24	20,003.49	247.5	N/A	1.7×10^{-7}	0.0037	<1.1	<0.8	11	0.1	2% C @ 140lph
TS-040	9/15/99	750.00	20,753.49	192.0	N/A	6.6×10^{-7}	0.0029	<1.0	<0.8	<2.2	0.0	2% C @ 140lph
TS-041	9/15/99	503.01	21,256.50	122.0	N/A	1.2×10^{-6}	0.0036	<1.1	<0.8	4.6	0.1	2% C @ 140lph
TS-042	9/16/99	750.00	22,006.50	162.5	N/A	8.9×10^{-7}	0.0029	<1.0	<0.8	17	0.0	2% C @ 140lph
DTS-042	9/16/99	N/A	22,006.50	135.0	N/A		0.0027	<1.0	<0.8	<2.2	0.0	QC Duplicate
TS-043	9/16/99	491.50	22,498.00	227.0	N/A	1.7×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.4	2% C @ 140lph
TS-044	9/17/99	750.00	23,248.00	120.0	N/A	5.2×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	2% C @ 140lph
TS-045	9/17/99	387.33	23,635.33	231.0	N/A	3.3×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	2% C @ 140lph
TS-046	9/20/99	750.00	24,385.33	158.0	N/A	7.3×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	2% C @ 140lph
TS-047	9/20/99	666.59	25,051.92	156.0	N/A	5.7×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.1	2% C @ 140lph
TS-048	9/21/99	750.00	25,801.92	91.0	N/A	3.1×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.1	2% C @ 140lph
TS-049	9/21/99	357.16	26,159.08	251.0	N/A	3.2×10^{-6}	0.0033	<1.0	<0.8	<2.2	0.1	2% C @ 140lph
TS-050	9/22/99	750.00	26,909.08	220.0	N/A	2.6×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.8	2% C @ 140lph
TS-051	9/22/99	384.68	27,293.76	232.5	N/A	1.7×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.1	2% C @ 140lph
TS-052	9/23/99	750.00	28,043.76	201.0	N/A	7.9×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1 7% C @ 140lph
DTS-052	9/23/99	N/A	28,043.76	210.0	N/A	9.9×10^{-8}	<0.0020	<1.0	<0.8	<2.2	0.0	QC Duplicate
TS-053	9/23/99	423.04	28,466.80	321.9	N/A	5.2×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1 7% C @ 140lph

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SAMPLE NUMBER 781433-	DATE SAMPLED	TREATED TONS	CUMULA- TIVE TONS	UCS - 7 psi	UCS - 28 psi	PERMEABILITY cm/second	ARSENIC mg/L	BENZO(a) PYRENE (ug/L)	DIBENZO(a,h) ANTHRACENE (ug/L)	PENTACHLORO- PHENOL (ug/L)	DIOXINS (TEQ) pg/L	COMMENTS
TREATMENT GOAL/ALLOWABLE												
TS-054	9/24/99	750.00	29,216.80	N/A	>100/80	$<1 \times 10^{-6}$	<50/75	<10/15	<4.4/6.6	<200/300	<30/45	
TS-055	9/24/99	561.49	29,778.29	409.0	N/A	9.6×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-056	9/27/99	750.00	30,528.29	177.7	N/A	8.0×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-057	9/27/99	635.57	31,163.80	305.0	N/A	5.6×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-058	9/28/99	750.00	31,913.86	229.0	N/A	5.3×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-059	9/28/99	652.45	32,566.31	280.0	N/A	5.4×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-060	9/29/99	750.00	33,316.31	191.0	N/A	2.7×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-061	9/29/99	381.66	33,697.97	96.0	N/A	1.9×10^{-6}	0.0053	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-062	9/30/99	750.00	34,447.97	226.5	N/A	1.4×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
DTS-062	9/30/99	N/A	34,447.97	160.0	N/A	1.4×10^{-6}	0.0037	<1.0	<0.8	<2.2	0.1	1.7% C @ 140lph
TS-063	9/30/99	567.22	35,015.19	178.0	N/A	8.2×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	QC Duplicate
TS-064	10/1/99	750.00	35,765.19	94.0	N/A	1.2×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-065	10/1/99	528.74	36,293.93	187.0	N/A	2.7×10^{-6}	0.0070	<1.0	<0.8	9.0	0.1	1.7% C @ 140lph
TS-066	10/4/99	750.00	37,043.93	440.0	N/A	2.8×10^{-7}	0.0039	<1.0	<0.8	7.0	0.1	1.7% C @ 140lph
TS-067	10/4/99	584.11	37,628.04	176.0	N/A	1.5×10^{-6}	0.0026	<0.5	<0.4	<1.1	0.0	1.7% C @ 140lph
TS-068	10/5/99	750.00	38,378.04	215.0	N/A	1.5×10^{-7}	0.0027	<0.5	<0.4	<1.1	0.0	1.7% C @ 140lph
TS-069	10/5/99	657.13	39,035.17	460.0	N/A	5.0×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-070	10/6/99	750.00	39,785.17	180.0	N/A	1.3×10^{-7}	0.0025	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-071	10/6/99	659.47	40,444.64	61.0	91	4.1×10^{-6}	0.0120	<1.0	<0.8	<2.2	0.9	1.7% C @ 140lph
TS-072	10/7/99	750.00	41,194.64	282.5	N/A	1.3×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
DTS-072	10/7/99	N/A	41,194.64	284.0	N/A	1.3×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.1	1.7% C @ 140lph
TS-073	10/7/99	594.97	41,789.61	399.0	N/A	1.3×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	QC Duplicate
TS-074	10/8/99	750.00	42,539.61	270.0	N/A	5.1×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-075	10/8/99	561.11	43,100.72	150.0	N/A	1.8×10^{-6}	<0.0020	<1.0	<0.8	88.0	0.0	1.7% C @ 140lph
TS-076	10/11/99	750.00	43,850.72	362.0	N/A	2.3×10^{-7}	<0.0020	<1.0	<0.8	7.1	0.0	1.7% C @ 140lph
TS-077	10/11/99	272.71	44,123.43	163.0	N/A	8.4×10^{-7}	0.0026	<1.0	<0.8	16.0	0.1	1.7% C @ 140lph
TS-078	10/12/99	766.25	44,889.68	110.0	N/A	9.0×10^{-7}	0.0050	<1.0	<0.8	12.0	0.1	1.7% C @ 140lph
TS-079	10/13/99	750.00	45,639.68	207.0	N/A	1.5×10^{-6}	<0.0020	<0.5	<0.4	<1.1	0.0	1.7% C @ 140lph
TS-080	10/13/99	456.69	46,096.37	240.0	N/A	2.5×10^{-7}	<0.0020	<0.5	<0.4	<1.1	0.0	1.7% C @ 140lph
TS-081	10/14/99	750.00	46,846.37	420.0	N/A	5.2×10^{-7}	<0.0020	<0.5	<0.4	<1.1	0.0	0.5% C @ 140lph
				355.0	N/A	1.5×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	0.5% C @ 140lph

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SAMPLE NUMBER	DATE SAMPLED	TREATED TONS	CUMULATIVE TONS	UCS - 7 psi	UCS - 28 psi	PERMEABILITY cm/second	ARSENIC mg/L	BENZO(a) PYRENE (ug/L)	DIBENZO(a,h) ANTHRACENE (ug/L)	PENTACHLORO- PHENOL (ug/L)	DIOXINS (TEQ) pg/L	COMMENTS
TREATMENT GOAL/ALLOWABLE												
TS-082	10/14/99	255.47	47,101.84	N/A	>100/80	$<1 \times 10^{-6}$	<50/75	<10/15	<4.4/6.6	<200/300	<30/45	
DTS-082	10/14/99	N/A	47,101.84	445.0	N/A	8.5×10^{-6}	0.0031	<1.0	<0.8	<2.2	0.1	0.5% C @ 140lph
TS-083	10/15/99	752.83	47,854.67	267.0	N/A	8.4×10^{-6}	0.0031	<1.0	<0.8	<2.2	0.5	QC Duplicate
TS-084	10/18/99	750.00	48,604.67	202.0	N/A	3.9×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-085	10/18/99	472.06	49,076.73	560.0	N/A	1.3×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-086	10/19/99	750.00	49,826.73	215.0	N/A	1.6×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-087	10/19/99	577.34	50,404.07	285.0	N/A	1.1×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-088	10/20/99	750.00	51,154.07	285.0	N/A	1.6×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.1	1.7% C @ 140lph
TS-089	10/20/99	611.51	51,765.58	345.0	N/A	5.5×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-090	10/21/99	750.00	52,515.58	199.0	N/A	1.1×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1.7% C @ 140lph
TS-091	10/21/99	597.77	53,113.35	137.5	N/A	1.0×10^{-6}	0.0031	<0.5	<0.4	<1.1	0.0	1.7% C @ 140lph
TS-092	10/22/99	750.00	53,863.35	145.0	N/A	1.3×10^{-7}	<0.0020	<0.5	<0.4	<1.1	0.3	1% C @ 140lph
DTS-092	10/22/99	N/A	53,863.35	245.0	N/A	4.0×10^{-6}	<0.0020	<0.5	<0.4	<1.1	0.0	1% C @ 140lph
TS-093	10/22/99	321.26	54,184.61	223.0	N/A	2.9×10^{-6}	<0.0020	<0.5	<0.4	<1.1	0.0	QC Duplicate
TS-094	10/25/99	750.00	54,934.61	48.0	N/A	5.2×10^{-7}	0.0051	<0.5	<0.4	<1.1	0.0	1% C @ 140lph
TS-095	10/25/99	612.77	55,547.38	400.0	N/A	2.7×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.1	1% C @ 140lph
TS-096	10/26/99	750.00	56,297.38	239.0	N/A	1.0×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.2	1% C @ 140lph
TS-097	10/26/99	599.38	56,896.76	121.0	N/A	5.6×10^{-6}	0.0027	<1.0	<0.8	<2.2	0.0	1% C @ 140lph
TS-098	10/27/99	800.99	57,697.75	416.0	N/A	3.2×10^{-7}	<0.0020	<1.0	<0.8	2.8	1.9	1% C @ 140lph
TS-099	10/28/99	750.00	58,447.75	310.0	N/A	8.0×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1% C @ 140lph
TS-100	10/28/99	574.89	59,022.64	121.0	N/A	1.7×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1% C @ 140lph
TS-101	10/29/99	750.00	59,772.64	200.0	N/A	3.5×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1% C @ 140lph
TS-102	10/29/99	587.50	60,360.14	470.0	N/A	5.6×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1% C @ 140lph
DTS-102	10/29/99	N/A	60,360.14	285.0	N/A	2.7×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.1	1% C @ 140lph
TS-103	11/1/99	0.00	60,360.14	235.0	N/A	1.2×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	QC Duplicate
TS-104	11/3/99	684.74	61,044.88	11.8	Reprocessed 11/13/99							1% C @ 140lph
TS-105	11/9/99	750.00	61,794.88	245.0	N/A	7.2×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.1	1% C @ 140lph
TS-106	11/9/99	435.13	62,230.01	360.0	N/A	4.9×10^{-7}	<0.0020	<1.0	<0.8	16.0	0.1	1% C @ 140lph
TS-107	11/10/99	802.14	63,032.15	135.0	N/A	4.5×10^{-6}	<0.0020	<1.0	<0.8	15.0	0.0	1.3% C @ 140lph
TS-108	11/11/99	750.00	63,782.15	217.0	N/A	1.1×10^{-6}	0.0110	<1.0	<0.8	27.0	0.1	1.3% C @ 140lph
				193.0	N/A	1.1×10^{-6}	<0.0020	<1.0	<0.8	73.0	0.0	1.3% C @ 140lph

OHM/IT PROJECT NUMBER 781433
JACKSON, TENNESSEE
TREATED SOIL SAMPLE RESULTS AS OF
1/10/00

SAMPLE NUMBER 781433-	DATE SAMPLED	TREATED TONS	CUMULA- TIVE TONS	UCS - 7 psi	UCS - 28 psi	PERMEABILITY cm/second	ARSENIC mg/L	BENZO(a) PYRENE (ug/L)	DIBENZO(a,h) ANTHRACENE (ug/L)	PENTACHLORO- PHENOL (ug/L)	DIOXINS (TEQ) pg/L	COMMENTS
	TREATMENT GOAL/ALLOWABLE											
TS-109	11/11/99	610.36	64,392.51	N/A	N/A	2.3×10^{-6}	<0.0020	<1.0	<0.8	2.9	11.4	1.3%C @ 140lph
TS-110	11/12/99	750.00	65,142.51	212.0	N/A	1.0×10^{-6}	0.0020	<1.0	<0.8	11.0	0.1	1.3%C @ 140lph
TS-111	11/12/99	475.18	65,617.69	363.0	N/A	1.5×10^{-6}	<0.0020	<1.0	<0.8	5.0	0.0	1.3%C @ 140lph
TS-112	11/15/99	750.00	66,367.69	135.0	N/A	1.6×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1.3%C @ 140lph
DTS-112	11/15/99	N/A	66,367.69	193.0	N/A	3.6×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	QC Duplicate
TS-113	11/15/99	527.66	66,895.35	185.0	N/A	4.3×10^{-7}	<0.0020	<1.0	<0.8	<2.2	0.0	1.3%C @ 140lph
TS-114	11/16/99	750.00	67,645.35	347.0	N/A	1.6×10^{-6}	<0.0020	<1.0	<0.8	<2.4	0.0	1.3%C @ 140lph
TS-115	11/16/99	526.02	68,171.37	220.0	N/A	5.2×10^{-6}	<0.0020	<1.0	<0.8	15.0	0.3	1.3%C @ 140lph
TS-116	11/17/99	750.00	68,921.37	383.0	N/A	1.3×10^{-6}	0.0029	<1.0	<0.8	7.3	0.1	1.3%C @ 140lph
TS-117	11/17/99	655.77	69,577.14	281.0	N/A	5.4×10^{-7}	0.0031	<1.0	<0.8	<2.2	0.0	1.3%C @ 140lph
TS-118	11/18/99	750.00	70,327.14	195.0	N/A	2.0×10^{-6}	0.0046	<1.0	<0.8	64.0	0.1	1.3%C @ 140lph
TS-119	11/18/99	604.07	70,931.21	328.0	N/A	2.0×10^{-7}	0.0028	<1.0	<0.8	85.0	0.1	1.3%C @ 140lph
TS-120	11/19/99	688.63	71,619.84	260.5	N/A	6.5×10^{-7}	0.0020	<1.0	<0.8	40.0	0.0	1.3%C @ 140lph
DTS-120	11/19/99	N/A	71,619.84	258.0	N/A	4.4×10^{-7}	0.0025	<1.0	<0.8	34.0	0.0	QC Duplicate
TS-121	11/21/99	750.00	72,369.84	288.0	N/A	3.5×10^{-7}	0.0026	<1.0	<0.8	6.8	0.6	1.3%C @ 140lph
TS-122	11/21/99	661.18	73,031.02	315.0	N/A	4.5×10^{-7}	0.0029	<1.0	<0.8	2.3	1.1	1.3%C @ 140lph
DTS-122	11/21/99	N/A	73,031.02	383.0	N/A	7.2×10^{-7}	0.0023	<1.0	<0.8	2.3	0.9	QC Duplicate
TS-123	11/22/99	750.00	73,781.02	277.0	N/A	2.7×10^{-6}	0.0024	<1.0	<0.8	19.0	0.1	1.3%C @ 140lph
TS-124	11/22/99	551.44	74,332.46	126.0	N/A	8.0×10^{-7}	0.0031	<1.0	<0.8	6.2	0.1	1.3%C @ 140lph
TS-125	11/23/99	750.00	75,082.46	345.0	N/A	4.4×10^{-7}	0.0020	<1.0	<0.8	<2.2	0.0	1.3%C @ 140lph
TS-126	11/23/99	454.41	75,536.87	301.0	N/A	4.5×10^{-7}	<0.0020	<1.0	<0.8	3.5	0.7	1.3%C @ 140lph
TS-127	11/29/99	750.00	76,286.87	157.0	N/A	6.3×10^{-7}	0.0024	<1.0	<0.8	6.8	0.0	1.3%C @ 140lph
TS-128	11/29/99	334.63	76,621.50	140.0	N/A	2.3×10^{-7}	0.0022	<1.0	<0.8	5.9	0.1	1.3%C @ 140lph
TS-129	11/30/99	750.00	77,371.50	370.0	N/A	2.2×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1.3%C @ 140lph
TS-130	11/30/99	413.55	77,785.05	152.0	N/A	1.4×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1.3%C @ 140lph
TS-131	12/1/99	750.00	78,535.05	240.0	N/A	6.9×10^{-7}	0.0021	<1.0	<0.8	5.5	0.2	1.3%C @ 140lph
TS-132	12/1/99	287.65	78,822.70	260.0	N/A	8.9×10^{-7}	<0.0020	<1.0	<0.8	9.4	0.1	1.3%C @ 140lph
DTS-132	12/1/99	N/A	78,822.70	283.0	N/A	7.6×10^{-7}	<0.0020	<1.0	<0.8	12.4	0.7	QC Duplicate
TS-133	12/2/99	750.00	79,572.70	85.0	N/A	3.5×10^{-6}	0.0044	<1.0	<0.8	5.4	0.0	1.3%C @ 140lph
TS-134	12/2/99	371.16	79,943.86	203.0	N/A	2.8×10^{-6}	<0.0020	<1.0	<0.8	<2.2	0.0	1.3%C @ 140lph

OHM/IT PROJECT NUMBER 781433

JACKSON, TENNESSEE

TREATED SOIL SAMPLE RESULTS AS OF

1/10/00

SAMPLE NUMBER 781433-	DATE SAMPLED	TREATED TONS	CUMULA- TIVE TONS	UCS - 7 psi	UCS - 28 psi	PERMEABILITY cm/second	ARSENIC mg/L	BENZO(a) PYRENE (ug/L)	DIBENZO(a,h) ANTHRACENE (ug/L)	PENTACHLORO- PHENOL (ug/L)	DIOXINS (TEQ) pg/L	COMMENTS
TREATMENT GOAL/ALLOWABLE												
TS-135	12/15/99	750.00	80,693.86	N/A	>100/80	$<1 \times 10^{-11} \times 10^{-6}$	<50/75	<10/15	<4.4/6.6	<200/300	<30/45	
				174.0	N/A	1.3×10^{-9}	<0.0020	<1.0	<0.8	<2.2	0.0	

OHM/IT PROJECT NUMBER 781433
JACKSON, TENNESSEE
MISCELLANEOUS SAMPLE RESULTS AS OF
2/7/00

EXCAVATION CONFIRMATION SAMPLES

SAMPLE NUMBER 781433-	DATE SAMPLED	TOTAL ARSENIC (mg/kg)	TOTAL BENZO(a)P YRENE (mg/kg)	TOTAL DIBENZO(a,h) ANTHRACENE (mg/kg)	TOTAL PENTACHLOROP HENOL (mg/kg)	TOTAL DIOXINS (TEQ) (pg/L)	COMMENTS
GOAL		225	41.5	55	3,000	2.25×10^{-3} mg/kg	
EC-001	9/20/99	4.8	19	2.10	25	1.480×10^{-3}	HAB-11
EC-002	9/20/99	3.3	12	2.20	<3.1	$.286 \times 10^{-3}$	HAB-17-2
DEC-002	9/20/99	3.2	12	3.00	<3.1	$.382 \times 10^{-3}$	QC Duplicate
EC-003	9/20/99	7.6	44	8.00	100	2.610×10^{-3}	HAB-17
EC-004	9/29/99	7.0	0.82	0.21	1.1	0.376×10^{-3}	Buffer Zone Perimeter
EC-005	9/29/99	<5.0	2.7	0.69	4.4	1.450×10^{-3}	Buffer Zone Perimeter
EC-006	9/29/99	<5.0	0.46	0.16	<0.31	0.213×10^{-3}	Buffer Zone Perimeter
EC-007	9/29/99	6.5	3.40	2.00	10	2.320×10^{-3}	Buffer Zone Perimeter
EC-008	9/29/99	6.8	9.80	2.50	65	2.280×10^{-3}	Buffer Zone Perimeter
EC-009	10/25/99	<5.0	0.70	<0.08	0.61	0.234×10^{-3}	Buffer Zone Perimeter
EC-010	10/25/99	<5.0	0.15	<0.08	<0.62	0.0163×10^{-3}	Buffer Zone Perimeter
EC-011	11/8/99	<2.5	1.50	<0.08	<0.62	0.00647×10^{-3}	HAB 22-5
EC-012	11/8/99	<2.5	0.46	<0.08	<0.62	0.00317×10^{-3}	HAB 15-9
DEC-012	11/8/99	<2.5	<0.10	<0.08	<0.62	0.0017×10^{-3}	QC Duplicate of HAB 15-9
EC-013	11/8/99	<2.5	7.30	1.40	9.1	0.342×10^{-3}	Drip Trak BZ Perimeter West
EC-014	11/8/99	2.8	0.70	<0.08	<0.62	0.0522×10^{-3}	Drip Trak BZ Perimeter East
EC-015	12/3/99	5.2	1.70	0.34	0.39	0.0661×10^{-3}	Southeast Buffer Zone
EC-016	12/3/99	<5.0	1.20	0.17	<0.62	0.00424×10^{-3}	Southeast Buffer Zone
EC-017	12/3/99	<5.0	1.30	0.25	1.0	0.361×10^{-3}	Southeast Buffer Zone

WATER TREATMENT DISCHARGE SAMPLES

SAMPLE	DATE	pH	SS (mg/	BOD5 (mg/	TEPH (ug/L)	TTO METALS	TTO VOLATILES
WT-001	10/14/99	6.63	11	<5.0	<100 f	<MDL	<MDL
WT-002	11/22/99	7.62	60	<5.0	1,100	See Summary	N/A
WT-003	12/3/99	7.39	<2.0	<5.0	<240	See Summary	N/A

SAMPLE	DATE	Oil & Grease	Pest/Herbicides/PCB's	TTO SVOC
WT-001	10/14/99	<1 mg/L	<MDL	See Note 1
WT-002	11/22/99	<1 mg/L	N/A	N/A
WT-003	12/3/99	<1 mg/L	N/A	N/A

Note 1: Fluoranthene 0.4 ug/L, Pyrene 0.3 ug/L, Di-n-octyl phthalate 2.6 ug/L

BACKFILL SOILS

SAMPLE	DATE	PEST's	SVOA's	PCB's	VOA's	METALS
BS-001	8/18/99	<MDL	See Note	<MDL	<MDL	See Summary

Note: 4-Chloro-3-methylphenol 0.35 mg/kg and Pyrene 0.21 mg/kg

DEBRIS FOR DISPOSAL

SAMPLE	DATE	TOTAL DIOXINS	TCLP VOA's	TCLP VOA's	TCLP RCRA METALS
DS-001	10/7/99	5.69 ppt	See Summary		

OHM/IT PROJECT NUMBER 781433
JACKSON, TENNESSEE
QUANTITY VERIFICATION SHEET
EXCAVATED AND TREATED SOIL

BATCH NUMBER	DATE TREATED	TREATED TONS	CUMULA- TIVE TONS	CUMULATIVE CUBIC YARDS @1.485 Tons/Yd ³	IT/DEC ACKNOWLEDGMENT
TS-101	10/29/99	750.00	59,772.64	40,250.93	HLJ DAS
TS-102	10/29/99	587.50	60,360.14	40,646.55	HLJ DAS
TS-103	11/1/99	378.30	60,738.44	40,901.30	HLJ DAS
TS-104	11/3/99	684.74	61,423.18	41,362.41	HLJ DAS
TS-105	11/9/99	750.00	62,173.18	41,867.46	HLJ DAS
TS-106	11/9/99	435.13	62,608.31	42,160.47	HLJ DAS
TS-107	11/10/99	802.14	63,410.45	42,700.64	HLJ DAS
TS-108	11/11/99	750.00	64,160.45	43,205.69	HLJ DAS
TS-109	11/11/99	610.36	64,770.81	43,616.70	HLJ DAS
TS-110	11/12/99	750.00	65,520.81	44,121.75	HLJ DAS
TS-111	11/12/99	475.18	65,995.99	44,441.74	HLJ DAS
TS-112	11/15/99	750.00	66,745.99	44,946.79	HLJ DAS
TS-113	11/15/99	527.66	67,273.65	45,302.12	HLJ DAS
TS-114	11/16/99	750.00	68,023.65	45,807.17	HLJ DAS
TS-115	11/16/99	526.02	68,549.67	46,161.35	HLJ DAS
TS-116	11/17/99	750.00	69,299.67	46,666.44	HLJ DAS
TS-117	11/17/99	655.77	69,955.44	47,109.04	HLJ DAS
TS-118	11/18/99	750.00	70,705.44	47,613.09	HLJ DAS
TS-119	11/18/99	604.07	71,309.51	48,049.87	HLJ DAS
TS-120	11/19/99	688.63	71,998.14	48,483.59	HLJ DAS
TS-121	11/21/99	750.00	72,748.14	48,988.64	HLJ DAS
TS-122	11/21/99	661.18	73,409.32	49,433.86	HLJ DAS
TS-123	11/22/99	750.00	74,159.32	49,938.93	HLJ DAS
TS-124	11/22/99	551.44	74,710.76	50,340.27	HLJ DAS
TS-125	11/23/99	750.00	75,460.76	50,845.32	HLJ DAS
TS-126	11/23/99	454.41	75,915.17	51,221.832	HLJ DAS
TS-127	11/29/99	750.00	76,665.17	51,626.37	HLJ DAS
TS-128	11/29/99	334.63	76,999.80	51,851.71	HLJ DAS
TS-129	11/30/99	750.00	77,749.80	52,356.76	HLJ DAS
TS-130	11/30/99	413.55	78,163.35	52,635.25	HLJ DAS
TS-131	12/1/99	750.00	78,913.35	53,140.30	HLJ DAS
TS-132	12/1/99	287.65	79,201.00	53,334.00	HLJ DAS
TS-133	12/2/99	750.00	79,951.00	53,839.05	HLJ DAS
TS-134	12/2/99	371.16	80,322.16	54,088.90	HLJ DAS
TS-135	12/15/99	750.00	81,072.16	54,594.04	HLJ DAS
TS-136					
TS-137					
TS-138					
TS-139					
TS-140					
TS-141					
TS-142					

OHM/IT PROJECT NUMBER 781433
JACKSON, TENNESSEE
QUANTITY VERIFICATION SHEET
EXCAVATED AND TREATED SOIL

CH SER	DATE TREATED	TREATED TONS	CUMULA- TIVE TONS	CUMULATIVE CUBIC YARDS @1.485 Tons/Yd ³	IT/TDEC ACKNOWLEDGMENT	
087	10/19/99	577.34	50,404.07	33,942.13	H.W.J.	DAS
088	10/20/99	750.00	51,154.07	34,447.18	H.W.J.	DAS
089	10/20/99	611.51	51,765.58	34,858.97	H.W.J.	DAS
090	10/21/99	750.00	52,515.58	35,364.02	H.W.J.	DAS
091	10/21/99	597.77	53,113.35	35,766.56	H.W.J.	DAS
092	10/22/99	750.00	53,863.35	36,271.61	H.W.J.	DAS
093	10/22/99	321.26	54,184.61	36,487.95	H.W.J.	DAS
S-094	10/25/99	750.00	54,934.61	36,993.00	H.W.J.	DAS
S-095	10/25/99	612.77	55,547.38	37,405.64	H.W.J.	DAS
S-096	10/26/99	750.00	56,297.38	37,910.69	H.W.J.	DAS
S-097	10/26/99	599.38	56,896.76	38,314.31	H.W.J.	DAS
S-098	10/27/99	800.99	57,697.75	38,853.70	H.W.J.	DAS
TS-099	10/28/99	750.00	58,447.75	39,358.75	H.W.J.	DAS
TS-100	10/28/99	574.89	59,022.64	39,745.88	H.W.J.	DAS

H.W.J.

11-4-99

OHM/IT PROJECT NUMBER 781433
JACKSON, TENNESSEE
QUANTITY VERIFICATION SHEET
EXCAVATED AND TREATED SOIL

BATCH NUMBER	DATE TREATED	TREATED TONS	CUMULA- TIVE TONS	CUMULATIVE CUBIC YARDS @1.485 Tons/Yd ³	IT/DEC ACKNOWLEDGMENT	
TS-044	9/17/99	750 00	23,248 00	15,655 22	J.W.S.	DAS
TS-045	9/17/99	387 33	23,635 33	15,916 05	J.W.S.	DAS
TS-046	9/20/99	750 00	24,385 33	16,421 10	J.W.S.	DAS
TS-047	9/20/99	666 59	25,051 92	16,869 98	J.W.S.	DAS
TS-048	9/21/99	750 00	25,801 92	17,375 03	J.W.S.	DAS
TS-049	9/21/99	357 16	26,159 08	17,615 54	J.W.S.	DAS
TS-050	9/22/99	750 00	26,909 08	18,120 59	J.W.S.	DAS
TS-051	9/22/99	384 68	27,293 76	18,379 63	J.W.S.	DAS
TS-052	9/23/99	750 00	28,043 76	18,884 68	J.W.S.	DAS
TS-053	9/23/99	423 04	28,466 80	19,169 56	J.W.S.	DAS
TS-054	9/24/99	750 00	29,216 80	19,674 61	J.W.S.	DAS
TS-055	9/24/99	561 49	29,778 29	20,052 72	J.W.S.	DAS
TS-056	9/27/99	750 00	30,528 29	20,557 77	J.W.S.	DAS
TS-057	9/27/99	635 57	31,163 86	20,985 76	J.W.S.	DAS
TS-058	9/28/99	750 00	31,913 86	21,490 81	J.W.S.	DAS
TS-059	9/28/99	652 45	32,566 31	21,930 17	J.W.S.	DAS
TS-060	9/29/99	750 00	33,316 31	22,435 22	J.W.S.	DAS
TS-061	9/29/99	381 66	33,697 97	22,692 23	J.W.S.	DAS
TS-062	9/30/99	750 00	34,447 97	23,197 28	J.W.S.	DAS
TS-063	9/30/99	567 22	35,015 19	23,579 25	J.W.S.	DAS
TS-064	10/1/99	750 00	35,765 19	24,084 30	J.W.S.	DAS
TS-065	10/1/99	528 74	36,293 93	24,440 35	J.W.S.	DAS
TS-066	10/4/99	750 00	37,043 93	24,945 40	J.W.S.	DAS
TS-067	10/4/99	584 11	37,628 04	25,338 74	J.W.S.	DAS
TS-068	10/5/99	750 00	38,378 04	25,843 80	J.W.S.	DAS
TS-069	10/5/99	657 13	39,035 17	26,286 31	J.W.S.	DAS
TS-070	10/6/99	750 00	39,785 17	26,791 36	J.W.S.	DAS
TS-071	10/6/99	659 47	40,444 64	27,235 44	J.W.S.	DAS
TS-072	10/7/99	750 00	41,194 64	27,740 50	J.W.S.	DAS
TS-073	10/7/99	594 97	41,789 61	28,141 15	J.W.S.	DAS
TS-074	10/8/99	750 00	42,539 61	28,646 20	J.W.S.	DAS
TS-075	10/8/99	561 11	43,100 72	29,024 05	J.W.S.	DAS
TS-076	10/11/99	750 00	43,850 72	29,529 10	J.W.S.	DAS
TS-077	10/11/99	272 71	44,123 43	29,712 74	J.W.S.	DAS
TS-078	10/12/99	766 25	44,889 68	30,228 74	J.W.S.	DAS
TS-079	10/13/99	750 00	45,639 68	30,733 79	J.W.S.	DAS
TS-080	10/13/99	456 69	46,096 37	31,041 32	J.W.S.	DAS
TS-081	10/14/99	750 00	46,846 37	31,546 37	J.W.S.	DAS
TS-082	10/14/99	255 47	47,101 84	31,718 41	J.W.S.	DAS
TS-083	10/15/99	752 83	47,854 67	32,225 36	J.W.S.	DAS
TS-084	10/18/99	750 00	48,604 67	32,730 41	J.W.S.	DAS
TS-085	10/18/99	472 06	49,076 73	33,048 30	J.W.S.	DAS
TS-086	10/19/99	750 00	49,826 73	33,553 35	J.W.S.	DAS

N. 1

OHM/IT PROJECT NUMBER 781433

JACKSON, TENNESSEE

QUANTITY VERIFICATION SHEET

EXCAVATED AND TREATED SOIL

BATCH NUMBER	DATE TREATED	TREATED TONS	CUMULATIVE TONS	CUMULATIVE CUBIC YARDS @1.485 Tons/Yd ³	IT/DEC ACKNOWLEDGMENT
TS-003	7/26/99	225.25	225.25	151.68	H.W.S. DAS
TS-004	7/27/99	546.14	771.39	519.45	H.W.S. DAS
TS-005	7/28/99	331.99	1,103.38	743.02	H.W.S. DAS
TS-006	7/29/99	162.14	1,265.52	852.20	H.W.S. DAS
TS-007	8/2/99	366.40	1,631.92	1,098.94	H.W.S. DAS
TS-008	8/3/99	559.33	2,191.25	1,475.59	H.W.S. DAS
TS-009	8/4/99	800.75	2,992.00	2,014.81	H.W.S. DAS
TS-010	8/5/99	773.04	3,765.04	2,535.38	H.W.S. DAS
TS-011	8/9/99	750.00	4,515.04	3,040.43	H.W.S. DAS
TS-012	8/9/99	167.38	4,682.42	3,153.14	H.W.S. DAS
TS-013	8/10/99	496.28	5,178.70	3,487.34	H.W.S. DAS
TS-014	8/11/99	724.89	5,903.59	3,975.48	H.W.S. DAS
TS-015	8/12/99	451.35	6,354.94	4,279.42	H.W.S. DAS
---	8/13/99	69.50	6,424.44	4,326.22	H.W.S. DAS
TS-016	8/24/99	595.18	7,019.62	4,727.02	H.W.S. DAS
TS-017	8/25/99	805.80	7,825.42	5,269.64	H.W.S. DAS
TS-018	8/26/99	394.30	8,219.72	5,535.16	H.W.S. DAS
TS-019	8/27/99	348.44	8,568.16	5,769.80	H.W.S. DAS
TS-020	8/30/99	750.00	9,318.16	6,274.85	H.W.S. DAS
TS-021	8/30/99	453.28	9,771.44	6,580.09	H.W.S. DAS
TS-022	8/31/99	750.00	10,521.44	7,085.14	H.W.S. DAS
TS-023	8/31/99	251.38	10,772.82	7,254.42	H.W.S. DAS
TS-024	9/1/99	750.00	11,522.82	7,759.47	H.W.S. DAS
TS-025	9/1/99	409.33	11,932.15	8,035.12	H.W.S. DAS
TS-026	9/2/99	750.00	12,682.15	8,540.17	H.W.S. DAS
TS-027	9/2/99	354.87	13,037.02	8,779.14	H.W.S. DAS
TS-028	9/3/99	539.76	13,576.78	9,142.61	H.W.S. DAS
TS-029	9/7/99	750.00	14,326.78	9,647.66	H.W.S. DAS
TS-030	9/7/99	252.41	14,579.19	9,817.64	H.W.S. DAS
TS-031	9/8/99	750.00	15,329.19	10,322.69	H.W.S. DAS
TS-032	9/8/99	480.54	15,809.73	10,646.28	H.W.S. DAS
TS-033	9/9/99	750.00	16,559.73	11,151.33	H.W.S. DAS
TS-034	9/9/99	258.01	16,817.74	11,325.08	H.W.S. DAS
TS-035	9/10/99	804.49	17,622.23	11,866.82	H.W.S. DAS
TS-036	9/13/99	750.00	18,372.23	12,371.87	H.W.S. DAS
TS-037	9/13/99	504.02	18,876.25	12,711.28	H.W.S. DAS
TS-038	9/14/99	750.00	19,626.25	13,216.33	H.W.S. DAS
TS-039	9/14/99	377.24	20,003.49	13,470.36	H.W.S. DAS
TS-040	9/15/99	750.00	20,753.49	13,975.41	H.W.S. DAS
TS-041	9/15/99	503.01	21,256.50	14,314.14	H.W.S. DAS
TS-042	9/16/99	750.00	22,006.50	14,819.19	H.W.S. DAS

211.7

EXCAVATION CONFIRMATION SAMPLES



SAMPLE NUMBER 781433-	DATE SAMPLED	TOTAL ARSENIC (mg/kg)	TOTAL BENZO(a)PYRENE (mg/kg)	TOTAL DIBENZO(a,h)ANTHRACENE (mg/kg)	TOTAL PENTACHLOROPHENO L (mg/kg)	TOTAL DIOXINS (TEQ) (pg/L)	COMMENTS
GOAL		225	41.5	55	3,000	2.26×10^{-3} mg/kg	
EC-001	9/20/99	4.8	19	2.10	25	1.480×10^{-3}	HAB-11
EC-002	9/20/99	3.3	12	2.20	<3.1	0.286×10^{-3}	HAB-17-2
DEC-002	9/20/99	3.2	12	3.00	<3.1	0.382×10^{-3}	QC Duplicate
EC-003	9/20/99	7.6	44	8.00	100	2.610×10^{-3}	HAB-17
EC-004	9/29/99	7.0	0.82	0.21	1.1	0.376×10^{-3}	Buffer Zone Perimeter
EC-005	9/29/99	<5.0	2.7	0.69	4.4	1.450×10^{-3}	Buffer Zone Perimeter
EC-006	9/29/99	<5.0	0.46	0.16	<0.31	0.213×10^{-3}	Buffer Zone Perimeter
EC-007	9/29/99	6.5	3.40	2.00	10	2.320×10^{-3}	Buffer Zone Perimeter
EC-008	9/29/99	6.8	9.80	2.50	65	2.280×10^{-3}	Buffer Zone Perimeter
EC-009	10/25/99	<5.0	0.70	<0.08	0.61	0.234×10^{-3}	Buffer Zone Perimeter
EC-010	10/25/99	<5.0	0.15	<0.08	<0.62	0.0163×10^{-3}	Buffer Zone Perimeter
EC-011	11/8/99	<2.5	1.50	<0.08	<0.62	0.00647×10^{-3}	HAB 22-5
EC-012	11/8/99	<2.5	0.46	<0.08	<0.62	0.00317×10^{-3}	HAB 15-9
DEC-012	11/8/99	<2.5	<0.10	<0.08	<0.62	0.0017×10^{-3}	QC Duplicate of HAB 15-9
EC-013	11/8/99	<2.5	7.30	1.40	9.1	0.342×10^{-3}	Drip Trak BZ Perimeter West
EC-014	11/8/99	2.8	0.70	<0.08	<0.62	0.0522×10^{-3}	Drip Trak BZ Perimeter East



11-22-99

EXCAVATION CONFIRMATION SAMPLES

SAMPLE NUMBER	DATE SAMPLED	TOTAL ARSENIC (mg/kg)	TOTAL BENZO(a)P YRENE (mg/kg)	TOTAL DIBENZO(a,h) ANTHRACENE (mg/kg)	TOTAL PENTACHLOROP HENOL (mg/kg)	TOTAL DIOXINS (TEQ) (pg/L)	COMMENTS
781433-	GOAL	225	41.5	55	3,000	2.25×10^{-3} mg/kg	
EC-001	9/20/99	4.8	19	2.10	25	1.480×10^{-3}	HAB-11
EC-002	9/20/99	3.3	12	2.20	<3.1	2.86×10^{-3}	HAB-17-2
DEC-002	9/20/99	3.2	12	3.00	<3.1	3.82×10^{-3}	QC Duplicate
EC-003	9/20/99	7.6	44	8.00	100	2.610×10^{-3}	HAB-17
EC-004	9/29/99	7.0	0.82	0.21	1.1	0.376×10^{-3}	Buffer Zone Perimeter
EC-005	9/29/99	<5.0	2.7	0.69	4.4	1.450×10^{-3}	Buffer Zone Perimeter
EC-006	9/29/99	<5.0	0.46	0.16	<0.31	0.213×10^{-3}	Buffer Zone Perimeter
EC-007	9/29/99	6.5	3.4	2.00	10	2.320×10^{-3}	Buffer Zone Perimeter
EC-008	9/29/99	6.8	9.8	2.50	65	2.280×10^{-3}	Buffer Zone Perimeter



 S. K. in

APPENDIX C

PRELIMINARY CLOSE-OUT REPORT AMERICAN CREOSOTE WORKS SITE JACKSON, TENNESSEE



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF SUPERFUND
NATIONAL PRIORITIES LIST SITES
JACKSON, TENNESSEE

MEMORANDUM

DATE May 15, 2000

SUBJECT Preliminary Close Out Report
American Creosote Works Superfund Site, Jackson TN

FROM Femi Akindele, *Femi Akindele*
Remedial Project Manager

THRU Harold Taylor, Chief *Harold Taylor*
Kentucky/Tennessee Section

THRU Robert Jourdan, Chief *Robert Jourdan*
North Superfund Remedial Branch

TO *for* Richard D. Green, Director *RDG*
Waste Management Division

The subject report has been prepared in accordance with OSWER Directive 9320 2-09A-P, "Close Out Procedures for National Priorities List Sites" EPA and the Tennessee Department of Environment and Conservation have determined that remedial action for American Creosote Site, in Jackson Tennessee, has been constructed as designed. Long-term monitoring activities, which are an integral part of the remedy, are pending at this time. Tennessee, the lead agency on this Fund-financed Remedial Action, has initiated activities necessary to achieve site completion

**PRELIMINARY CLOSE OUT REPORT
AMERICAN CREOSOTE WORKS SUPERFUND SITE
JACKSON, TENNESSEE**

I. INTRODUCTION

The purpose of this Preliminary Close Out Report is to document the completion of remedial construction activities for the subject site in accordance with OSWER Directive 9320 2-09A-P, "Close Out Procedures for National Priorities List Sites" EPA and the Tennessee Department of Environment and Conservation, Division of Superfund, conducted a pre-final inspection of the site on January 5, 2000, and determined that the remedy construction has been accomplished in accordance with remedial design (RD) plans and specifications. The State, as the lead agency on the project, has initiated activities necessary to achieve performance standards and site completion.

II. SUMMARY OF SITE CONDITIONS

Background

The American Creosote Works Superfund Site (ACW) is an abandoned 60-acre facility which utilized creosote and pentachlorophenol (PCP) to preserve wood. The plant was operated from the early 1930s to December 1981, by the American Creosote Works, Inc., which went bankrupt in May 1982. Due to the bankruptcy, no potentially responsible parties have been involved in the remedial activities conducted at the site to date.

ACW is located immediately southwest of downtown Jackson, Tennessee, in an area used predominantly for industrial purposes. It is bounded on the south by the Seaboard Railroad, on the southwest by the south fork of the Forked Deer River, on the west and north by Central Creek, and on the east by an industrial yard. Jackson has a population of more than 60,000 people. Several public and private wells are located within a 3-mile radius of the site, including a city well field. Wetlands along the river support a large variety of wildlife.

Between early 1930s and 1973, the plant apparently discharged untreated process water on-site with minimal control and routinely polluted the Forked Deer River. In 1973, a levee was built around the facility to contain the wastewater and surface runoff. Between 1974 and 1975, the plant installed a wastewater treatment system and oil-water separator to control environmental pollution. Pits created during the construction of the levee were used to store treated process water and sludge but the pits frequently overflowed during heavy rains, flooding the main process area and releasing waste into the river.

Contaminants of concern at the site included arsenic, dioxin, PCP, and polyaromatic hydrocarbons (PAHs). The site posed potential human health hazards and environmental threats primarily through incidental ingestion, dermal contact with contaminated soil, and/or inhalation of

contaminated dust by trespassers and unprotected workers at the site. In addition, groundwater, surface water, and sediments from the site, which were contaminated with creosote and PCP, were transported offsite by various mechanisms, thereby posing a threat to human health and the environment outside the boundaries of the site.

Enforcement actions began at the site in November 1981, when the State installed four monitoring wells around the property. In December 1981, the facility was issued a National Pollution Discharge Elimination Systems Permit. In the same month, the plant closed down. The operator filed for bankruptcy protection under Chapter 11 in May 1982. During 1982 and 1983, the State conducted several inspections of the facility. All inspections resulted in citations for permit violations by the operator. Concurrently, the State collected environmental samples to evaluate the site and concluded that human health and the environment were at risk due to the prevailing conditions. Based on the facility's conditions and insolvency of the operator, the State requested emergency response from EPA in June 1983. Ranking of the site for the National Priorities List (NPL) was completed in September 1984, and actual listing occurred in the following month.

Remedial Activities

Since 1983, EPA has conducted a series of clean-up activities at American Creosote Site, including emergency removal, treatment and disposal of hazardous waste, pollution control, environmental sampling, laboratory analyses, remedial investigations and feasibility studies. Initially, EPA inspected the site and conducted field sampling which confirmed that soils, surface water, sludge, and shallow sub-surface water were contaminated by creosote and PCP. This led to an immediate removal, treatment, and proper disposal of several thousand gallons of hazardous liquids and sludge at a cost of approximately \$735,000.

In late 1985, EPA approved an action memo to fund a Remedial Investigation/Feasibility Study (RI/FS) for the site. The RI/FS was conducted by the US Army Corps of Engineers. Based on the results of the work, a Record of Decision (ROD) was published in January 1989. The ROD outlined plans for cleaning the site in phases (operable units), and identified the tasks for Operable Unit 1 (OU1) as follows:

- 1 Deed restrictions to limit further use of the site
- 2 Construction of flood protection dike around the site and site stabilization
- 3 Removal and disposal of tanked liquids and sludge
- 4 Removal and disposal of site structures.
- 5 Installation of security fencing around the site

Recording of deed restrictions is pending at this time. However, other OU1 tasks were accomplished between January 1989 and August 1991. The flood protection levee was constructed and functional by early 1989. It was upgraded for improved effectiveness in 1990. Tanked liquids and sludge were accumulated, treated on-site and finally incinerated off-site. Site structures, including buildings and tanks, railroad lines, railroad ties, and other plant equipment determined to constitute immediate hazard were demolished, dismantled and/or salvaged.

OU1 activities focused on mitigating hazardous conditions at the plant process area, protecting the river, and preventing indiscriminate access to the site. Other problems and remedial activities related to contaminated soil and groundwater at the site were deferred to OU2.

On September 30, 1996, EPA issued the OU2 ROD which concluded that the site would continue to be used as an industrial property. Therefore, industrial clean-up scenarios were found appropriate for the site. It also concluded that there were no evidences of groundwater contamination outside the boundaries of the site but that the groundwater required a long-term monitoring program to ensure that its conditions were not deteriorating with time. Therefore, the ROD specified a remedy which called for removal and offsite disposal of liquids (creosote and water), immobilization, deed restriction, and monitoring. The liquid recovery component, essentially, would drain creosote and water from affected soil to enhance immobilization effectiveness. The liquids would be treated on-site before disposal at approved facilities off-site. The immobilization phase would stabilize residual contaminants to limit their mobility, and solidify contaminated soil into a mass of treated waste with little or no potential to disintegrate. This would be achieved by excavating and mixing of contaminated soils with appropriate chemical reagents. The final product would be buried in the excavated area, properly graded, and capped. The other requirements of the remedy are institutional controls which would be reflected in the property deed limiting the site to industrial use, and a five-year sampling program to monitor contaminants in the groundwater, surface water, and sediment.

Risk based, soil remedial goals specified by the ROD in mg/kg are: arsenic, 225; benzo(a)pyrene, 41.5; dibenzo(a,h)anthracene, 55; pentachlorophenol, 3,000; and dioxin, 0.00225. These clean-up goals were calculated to achieve the cancer risk protection level for future adult workers and were determined to be protective of current youth trespassers also.

While the ROD was under preparation, EPA's National Risk Management Research Laboratory (NRMRL) in Cincinnati, Ohio began to provide technical support for the site as requested by the region. In early 1996, NRMRL included American Creosote Site in a national study of wood preserving waste treatment using solidification/stabilization (S/S) technologies. Science Applications International Corporation (SAIC) conducted the study for NRMRL. Contaminated soils were collected from three sites and three S/S vendors were chosen to treat the soils with several different chemical formulations. The results of the study indicated that soil contaminants associated with preserving wood by PCP, and creosote, could be immobilized effectively, using S/S technologies.

To demonstrate successful application of the formulations, solidified products were subjected to leach tests, in addition to measurements of permeability and unconfined compressive strength (UCS). The following analytical results were obtained:

Arsenic	<50 ppb
Pentachlorophenol	<200 ppb
BAP potency	<10 ppb
Dibenzo(a,h)anthracene	<4.4 ppb
TCDD-TEQ	<30 ppq
Permeability	<1x10E-6 cm/sec
UCS (28 day cure)	>100 psi

In October 1996, NRMRL issued a follow-up Work Assignment (Contract No. 68-C5-0001, WA 1-20) to SAIC to conduct a site specific, S/S treatability study for ACW soils using various mixtures of Portland cement, fly ash, carbon, lime and/or kiln dust. The above laboratory results which were obtained from previous tests were specified as treatment goals for the site specific study. The study was completed in late 1996, and the results were reported including reagent mixtures, ratios, and associated costs for meeting the specified treatment goals.

EPA contracted with Bechtel to conduct a performance based remedial design for the site in early 1997. Under the contract, Bechtel reviewed pertinent site reports, acquired and evaluated a limited amount of new field data. The remedial design (RD), which was completed in September 1997, was prepared in accordance with the OU2 ROD and the S/S treatability results. As requested by EPA, Bechtel prepared the RD report in the format of a bid package for easy incorporation into a request for proposal at a later date.

With the RD in place, and because the state's technical staff have been involved actively in the remedial activities conducted by EPA at the site so far, the Region believed that, with appropriate technical support from EPA, the state could take the lead for the remaining OU2 remedial activities successfully. Therefore, EPA encouraged the State to consider conducting the remedial action. In August 1998, the State submitted a Fund-financed State-lead Cooperative Agreement for the work. EPA approved and funded the agreement for a total amount of \$6,000,000.00, including the State's ten percent share in September 1998.

The State prepared the RA scope of work and requested bids from several companies in early October, 1998. A pre-bid meeting, which was mandatory for all interested bidders, was held later in the month to discuss the RA requirements and to visit the site. EPA personnel from the Region and NRMRL attended the meeting to assist the state. Four companies submitted bids for the project at costs ranging from 2.8 to 12 million dollars, with OHM Remediation Services Corp. being the lowest bidder. A review of OHM's proposal and a subsequent meeting with the company's personnel by the State and EPA confirmed that the company was capable of performing the RA satisfactorily. Therefore, the State awarded the contract to OHM in March, 1999.

Work plans for field activities, health and safety plan, sampling/analysis plan, and quality assurance/quality control plan were submitted for State/EPA review and comments by the contractor before mobilizing to the site in May 1999. The RA construction proceeded according to the work plan which was approved by the State and EPA. Some field and laboratory difficulties were encountered and resolved by the contractor without jeopardizing site clean-up objectives. The State maintained daily presence at the site and provided contractor oversight during the field work. EPA project manager and the Superfund Technical Assistance Response Team leader from NRMRL assisted the State on various technical issues arising and visited the site frequently during the construction period.

The State and EPA conducted a pre-final inspection of the RA on January 5, 2000. The inspection, and a review of records prepared by the contractor indicated that all soil remediation work, except grass seeding, was completed in accordance with the approved RD and in compliance with OU2 ROD requirements. The specific work completed at that time included the following:

- 1 Site preparation, structure demolition, segregation of scraps/debris/railroad ties, and disposal.
- 2 Surveys to delineate soil treatment area, and to ensure proper grading.
- 3 Collection, treatment, and disposal of free creosote, emulsion and water from treatment area.
- 4 Excavation and staging of contaminated soil for treatment.
- 5 Treatment of excavated soil with cement, carbon, and fly ash to stabilize contaminants.
- 6 Backfilling and compaction of treated soil to solidify product.
- 7 Covering the backfilled area with geosynthetic clay liner (GCL).
- 8 Installing an eighteen inch layer of fill dirt and a six inch layer of top soil over the GCL.
- 9 Site grading.
- 10 Field sampling and laboratory analyses.

Due to inclement weather, seeding for grass was not accomplished until May 11, 2000. A total of approximately 81,000 tons of contaminated soil from various parts of the site, 520,000 gallons of water, and 16,000 gallons of creosote were processed during the RA. The treated soils were compacted and capped in the backfilled area, which covered approximately 7.2 acres of the site.

III. DEMONSTRATION OF CLEAN-UP ACTIVITY QUALITY ASSURANCE AND QUALITY CONTROL

As stated previously, all RA construction activities conducted by the contractor were monitored closely by the State and EPA personnel to ensure that the field activities were consistent with the RD and RA work plan. All reports which formed the bases of field and laboratory activities incorporated necessary State and EPA procedures and protocol. In support of the State, EPA conducted independent laboratory analysis of split samples to monitor and validate analytical results reported by the contractor during the RA. The QA/QC program used throughout the RA was in conformance with EPA and State standards. Thus, the State and EPA maintained appropriate measures for a satisfactory quality of clean-up work and determined that the RA was conducted in accordance with the ROD requirements.

IV. ACTIVITIES AND SCHEDULE FOR SITE COMPLETION

The RA activities remaining to be completed at the site include, the preparation remedial action report, deed restriction recording, monitoring of groundwater, surface water and sediment, approving the operations and maintenance (O&M) plan, and preparing the final close-out report. The activities are planned to be completed according to the following schedule.

Task	Estimated Completion Date	Responsible Organization
O&M plan preparation	06/30/00	State/EPA
Remedial Action report	06/30/00	State contractor
Deed restriction recording	06/30/00	State/EPA
Multi-media monitoring	02/28/05	State
Final Inspection	04/30/05	State/EPA
Final Close-out report preparation	09/30/05	EPA
Deletion from NPL	09/30/05	EPA

V. SUMMARY OF REMEDIATION COSTS

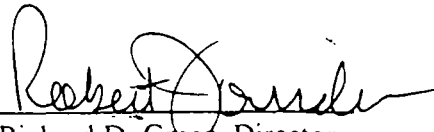
The original cost estimate for the RA described in the OU2 ROD was \$6 million. The cost of work completed is approximately \$3.3 million, and the remaining work, including seeding

and site monitoring for five years, is estimated at \$0.5 million. Therefore, total cost of the RA is expected to be approximately \$3.8 million. Actual cost data will be included in the Final Close Out Report.

As stated earlier, OHM's bid for the project was \$2.8 million which did not include the cost of site monitoring. The contractor's projected total billing of approximately \$3.3 million for the S/S work reflects change orders, including treatment of more contaminated soil and less quantity of liquids than estimated originally, necessary disposal of debris not included in the scope of work, and installation of access road. Details of the change orders will be included in the RA report.

VI. FIVE-YEAR REVIEW

Hazardous substances will remain at the site above health-based levels after the completion of the remedial action. Pursuant to CERCLA section 121(c), and as provided in OSWER Directive 9355.7-02, Structures and Components of Five-Year Reviews, May 23, 1991, and its supplement (OSWER 9355.7-02A, July 26, 1994), EPA must conduct a statutory five-year review of the RA. Therefore, a five year review will be conducted by May 2004, which is five years after mobilization to the site for OU2 remedy construction.


for Richard D. Green, Director
Waste Management Division

5/24/00
Date

APPENDIX D

**HISTORICAL DATA AND MAPS REPORT
AMERICAN CREOSOTE WORKS SITE
JACKSON, TENNESSEE**

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Figure 8 – Potentiometric Surface Map Fort Pillow Aquifer (March 2, 1987)

Figure 9 – Potentiometric Surface Map Alluvial Aquifer (March 2003)

Figure 10–Potentiometric Surface Map Fort Pillow Aquifer (March 2003)

Figure 11–Groundwater Concentration Map Sum of VOCs in Alluvial Aquifer (Jan '87-Oct '88)

Figure 12–Groundwater Concentration Map Sum of VOCs in Fort Pillow Aquifer (Jan '87-Oct '88)

Figure 13–Groundwater Concentration Map Sum of PAHs in Alluvial Aquifer (Jan '87-Oct '88)

Figure 14–Groundwater Concentration Map Sum of PAHs in Fort Pillow Aquifer (Jan '87-Oct '88)

Figure 15–Groundwater Concentration Map Sum of PCPs in Alluvial Aquifer (Jan '87-Oct '88)

Figure 16–Groundwater Concentration Map Sum of PCPs in Fort Pillow Aquifer (Jan '87-Oct '88)

Figure 17–Groundwater Concentration Map Sum of VOCs in Alluvial Aquifer (March 3, 2003)

Figure 18–Groundwater Concentration Map Sum of VOCs in Fort Pillow Aquifer (March 3, 2003)

Figure 19–Groundwater Concentration Map Sum of PAHs in Alluvial Aquifer (March 3, 2003)

Figure 20–Groundwater Concentration Map Sum of PAHs in Fort Pillow Aquifer (March 3, 2003)

Figure 21–Groundwater Concentration Map Sum of PCPs in Alluvial Aquifer (March 3, 2003)

Figure 22–Groundwater Concentration Map Sum of PCPs in Fort Pillow Aquifer (March 3, 2003)

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Table 1
Historical Soil Analytical Data
American Creosote Works TDEC-DSF Site No. 57-508
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Sample Information			PAHs								PCPs	SUM of VOCs	SUM of PAHs	SUM of PCPs
Sample ID	Sample Date	Sample Interval BGS	Acenaphthene	Benzo (a) anthracene	Benzo (b) Fluoranthene	Benzo (k) Fluoranthene	Chrysene	Fluoranthene	Naphthalene	Pyrene	Pentachlorophenol			
Region IX PRGs (Residential) mg/L			3,700.0	0.62	0.62	6.2	62.0	2,300.0	2,700.0	56.0	2,300.0	3.0	NA	NA
Region IX PRGs (Industrial) mg/L			29,000.0	2.1	2.1	210	210.0	22,000.0	0.0	190.0	29,000.0	9.0	NA	NA
HAB-1	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	0.18	ND	0.065	ND
HAB-2	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.006	9.92	ND
HAB-3	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	30.3	ND
HAB-4	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	17.9	ND
HAB-5	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	19.0	ND
HAB-6	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.346	ND
HAB-7	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	4,790.0	ND
HAB-8	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.0	892.0	ND
HAB-9	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	22.0	NA	ND
HAB-10	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	31.2	1,270.0	ND
HAB-11	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	1,417.0	ND
HAB-12	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	5.8	ND
HAB-13	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	NA	ND
HAB-14	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	10.35	ND
HAB-15	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	10.0	1,465.0	ND
HAB-16	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	NA	ND
HAB-17	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	906.0	ND
HAB-18	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	NA	ND
HAB-19	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	200.0	702.0	ND
HAB-20	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	25.77	5,200.0	380.0
HAB-21	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	26.88	21,330.0	380.0
HAB-22	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	128.00	NA	54.0

Table 1
Historical Soil Analytical Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
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Sample Information			PAHs										PCPs			
Sample ID	Sample Date	Sample Interval BGS	Acenaphthene	Benzo (a) anthracene	Benzo (b) Fluoranthene	Benzo (k) Fluoranthene	Chrysene	Fluoranthene	Fluorene	Naphthalene	Pyrene	Pentachlorophenol	SUM of VOCs	SUM of PAHs	SUM of PCPs	
Region IX PRGs (Residential) mg/L			3,700.0	0.62	0.62	6.2	62.0	2,300.0	2,700.0	56.0	2,300.0	3.0	NA	NA	NA	
Region IX PRGs (Industrial) mg/L			29,000.0	2.1	2.1	210	210.0	22,000.0	0.0	190.0	29,000.0	9.0	NA	NA	NA	
SB-1	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.647	ND	
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2	1.0	ND	
SB-2	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.80	0.077	ND	
SB-3	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	
		5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	
SB-4	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	ND	ND	
SB-5	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	23.40	ND	
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10.6	2.380	ND	
6	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.124	ND	
7	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	

Table 1
Historical Soil Analytical Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
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Sample Information			PAHs								PCPs	SUM of VOCs			SUM of PAHs		SUM of PCPs
Sample ID	Sample Date	Sample Interval BGS	Acenaphthene	Benzo (a) anthracene	Benzo (b) Fluoranthene	Benzo (k) Fluoranthene	Chrysene	Fluoranthene	Fluorene	Naphthalene	Pyrene	Pentachlorophenol	SUM of VOCs	SUM of PAHs	SUM of PCPs		
Region IX PRGs (Residential) mg/L			3,700.0	0.62	0.62	6.2	62.0	2,300.0	2,700.0	56.0	2,300.0	3.0	NA	NA	NA		
Region IX PRGs (Industrial) mg/L			29,000.0	2.1	2.1	210	210.0	22,000.0	0.0	190.0	29,000.0	9.0	NA	NA	NA		
8	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.002	ND		
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.101	ND		
9	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.065	1,164.0	ND		
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	14,610.0	ND		
10	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	3,247.0	ND		
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND		
11	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0025	ND	ND		
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.005	ND		
12	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0211	NA	21.51		
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.18	1,036.20	110.00		

Table 1
Historical Soil Analytical Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
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Sample Information			PAHs										PCPs	SUM of VOCs			SUM of PAHs	SUM of PCPs
Sample ID	Sample Date	Sample Interval BGS	Acenaphthene	Benzo (a) anthracene	Benzo (b) Fluoranthene	Benzo (k) Fluoranthene	Chrysene	Fluoranthene	Fluorene	Naphthalene	Pyrene	Pentachlorophenol	SUM of VOCs	SUM of PAHs	SUM of PCPs			
Region IX PRGs (Residential) mg/L			3,700.0	0.62	0.62	6.2	62.0	2,300.0	2,700.0	56.0	2,300.0	3.0	NA	NA	NA			
Region IX PRGs (Industrial) mg/L			29,000.0	2.1	2.1	210	210.0	22,000.0	0.0	190.0	29,000.0	9.0	NA	NA	NA			
13	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND			
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.069	ND			
14	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	1.14	0.14			
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.642	ND			
15	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	575.0	ND			
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.0	4,103.0	ND			
16	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.163	563.70	21.00			
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	2.94	0.341			
17	Jan 87-Oct 88	0-5'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	8.22	ND			
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	17.00	18.10	ND			
18	Jan 87-Oct 88	5-15'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	17.00	18.10	ND			
		15-25'	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.40	ND			

Table 1
Historical Soil Analytical Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
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Sample Information			PAHs							PCPs	SUM of VOCs	SUM of PAHs	SUM of PCPs
Sample ID	Sample Date	Sample Interval BGS	Acenaphthene	Benzo (a) anthracene	Benzo (b) Fluoranthene	Benzo (k) Fluoranthene	Chrysene	Fluoranthene	Fluorene	Naphthalene	Pyrene		
Region IX PRGs (Residential) mg/L			3,700.0	0.62	0.62	6.2	62.0	2,300.0	2,700.0	56.0	2,300.0	NA	NA
Region IX PRGs (Industrial) mg/L			29,000.0	2.1	2.1	210	210.0	22,000.0	0.0	180.0	29,000.0	NA	NA
GP-6	07/08/02	3'-4'	160.0	ND	ND	ND	ND	460.00	160.00	80.0	220.0	ND	ND
		5'-6'-5'	230.0	ND	ND	ND	90.00	620.00	230.00	76.0	300.0	2.00	ND
GP-12	07/08/02	2'-4'	300.0	80.0	93.0	ND	130.00	910.00	250.00	120.0	460.0	ND	ND
		5'-6'-5'	140.0	ND	ND	ND	ND	480.00	150.00	ND	210.0	0.26	ND
GP-20	07/08/02	4'-5'	37.0	12.0	18.0	7.10	26.00	190.00	49.00	13.0	92.0	ND	ND
		6'-5'-7'-5'	78.0	ND	ND	ND	43.00	330.00	90.00	ND	150.0	ND	ND
GP-22	07/08/02	5'-6'	78.0	ND	ND	ND	ND	19.00	7.50	3.8	10.0	ND	ND
		6'-5'-7'-5'	11.0	ND	ND	ND	4.00	24.00	9.90	ND	13.0	ND	ND
GP-31	07/08/02	4'-5'	14.0	6.0	7.9	4.20	8.50	53.00	12.00	ND	28.0	0.08	ND
		6'-8'	ND	ND	ND	ND	ND	0.88	ND	ND	0.49	ND	ND
GP-21	07/08/02	6'-5'-7'-5'	28.0	8.5	7.1	ND	8.80	72.00	26.00	11.0	35.0	ND	4.5
		5'-7'	100.0	ND	ND	ND	47.00	340.00	110.00	46.0	160.0	ND	ND
GP-1	07/08/02	3'-4'	0.6	0.81	0.64	ND	0.93	5.90	0.47	0.78	3.6	0.08	1.5
		6'-7'	42.0	9.3	15.0	4.30	20.00	130.00	38.00	18.0	65.0	0.50	4.1

Notes. NA - Not available, ND - Not Detected (below laboratory detection limits), BGS - Below Ground Surface
 *All concentrations presented in milligrams per kilogram (mg/kg) of parts-per-million (ppm)
 Utilized the October 1, 2002 EPA Region IX preliminary Remediation Goals (PRGs)
 Bold cells indicates that concentration exceeds the Region IX PRGs for Residential Soils
 Bold and Shaded indicates that concentration exceeds the Region IX PRGs for Industrial Soils
 Sums of Volatile Organic Compounds (VOCs), derived from S&ME Final RI, 1988
 Sum of Polynuclear Aromatic Hydrocarbons (PAHs) derived from Final RI, 1988
 Sum of Pentachlorophenol (PCPs) derived from S&ME Final RI, 1988

Table 2
Historical Potentiometric Surface Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
(Page 1 of 12)

Well Data							Potentiometric Data		
Well ID	Date Gauged	Aquifer	Screen Interval (ft bgs)	Well Depth (ft bgs)	Height of TOC AGS (ft)	Ground Surface Elevation (ft)	DNAPL Thickness (ft)	Depth to Water from TOC (ft)	Groundwater Elevation (MSL) (ft)
1S	-	Alluvial	20.5-25.5	25.50	NA	350.00	No Additional Information Available/Well Not Located	NA	342.31
	04/02/87								
1M	-	Fort Pillow	54.5-59.5	59.50	NA	350.00	No Additional Information Available/Well Not Located	NA	341.94
	04/02/87								
1D	-	Fort Pillow	112-122	122.00	NA	350.00	No Additional Information Available/Well Not Located	NA	341.96
	04/02/87								
2S	03/24/03	Alluvial	12-17	17.00	4.89	342.00		7.80	339.09
	07/10/02							9.85	337.04
	01/14/02							8.66	338.23
	05/17/01							9.85	337.04
	10/21/92							7.44	339.45
	10/17/90							7.65	339.24
	03/22/90							5.20	341.69
	04/02/87							NA	335.91
2M	03/24/03	Alluvial	29.5-34.5	34.50	5.12	342.00		7.86	339.26
	07/10/02							9.90	337.22
	01/14/02							8.71	338.41
	05/17/01							9.85	337.27
	10/21/92							7.79	339.33
	10/17/90							7.87	339.25
	03/22/90							5.42	341.70
	04/02/87							NA	335.70
2D	03/24/03	Fort Pillow	116.5-126.5	126.50	5.44	342.00		7.74	339.70
	07/10/02							9.70	337.74
	01/14/02							8.63	338.81
	05/17/01							9.66	337.78
	10/21/92							6.44	341.00
	10/17/90							6.52	340.92
	03/22/90							4.30	343.14
	04/02/87							NA	337.38

Table 2
Historical Potentiometric Surface Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
(Page 2 of 12)

Well Data							Potentiometric Data		
Well ID	Date Gauged	Aquifer	Screen Interval (ft bgs)	Well Depth (ft bgs)	Height of TOC AGS (ft)	Ground Surface Elevation (ft)	DNAPL Thickness (ft)	Depth to Water from TOC (ft)	Groundwater Elevation (MSL) (ft)
3S	03/24/03	Alluvial	8.5-13.5	13.50	3.50	343.00		NG	NA
	10/21/92							6.54	339.96
	10/17/90							6.56	339.94
	03/22/90							4.95	341.55
	04/02/87							NA	337.36
3M	03/24/03	Alluvial	32.5-37.5	37.50	3.50	343.00		NG	NA
	10/21/92							6.36	340.14
	10/17/90							6.52	339.98
	03/22/90							4.85	341.65
	04/02/87							NA	337.44
3D	03/24/03	Fort Pillow	125.5-135.5	135.50	3.50	343.00		NG	NA
	10/21/92							5.88	340.62
	10/17/90							5.98	340.52
	03/22/90							3.80	342.70
	04/02/87							NA	338.34

Table 2
Historical Potentiometric Surface Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
(Page 4 of 12)

Well Data										Potentiometric Data		
Well ID	Date Gauged	Aquifer	Screen Interval (ft bgs)	Well Depth (ft bgs)	Height of TOC AGS (ft)	Ground Surface Elevation (ft)	DNAPL Thickness (ft)	Depth to Water from TOC (ft)	Groundwater Elevation (MSL) (ft)			
5S	- 04/02/87	Alluvial	14.5-19.5	19.50	NA			Well Destroyed				
5M	- 04/02/87	Fort Pillow	57-62	62.00	NA		DNAPL	NA	338.65			
5D	- 04/02/87	Fort Pillow	100.5-110.5	110.50	NA			Well Destroyed				
6	- 04/02/87	Alluvial	16.5-21.5	21.50	NA		No Additional Information Available/Well Not Located	NA	339.27			
7	- 04/02/87	Alluvial	14-19	19.00	NA		No Additional Information Available/Well Not Located	NA	341.59			
8	- 04/02/87	Alluvial	14-19	19.00	NA		No Additional Information Available/Well Not Located	NA	341.82			
9	- 04/02/87	Alluvial	15-20	20.00	NA		No Additional Information Available/Well Not Located	NA	341.24			
10	03/24/03 10/21/92 10/17/90 03/22/90 04/02/87	Alluvial	12.5-17.5	17.50	4.64	341.00	DNAPL	NA	339.86			
10X	03/24/03 10/21/92 10/17/90 03/22/90	Alluvial	11-16	16.00	5.94	341.00	DNAPL	NA	338.88			
								NG	NA			
								5.52	340.12			
								5.44	340.20			
								2.98	342.66			
								NA	338.88			
								NG	NA			
								5.05	341.89			
								4.93	342.01			
								2.50	344.44			

Table 2
Historical Potentiometric Surface Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
(Page 5 of 12)

Well ID	Date Gauged	Well Data					Potentiometric Data		
		Aquifer	Screen Interval (ft bgs)	Well Depth (ft bgs)	Height of TOC AGS (ft)	Ground Surface Elevation (ft)	DNAPL Thickness (ft)	Depth to Water from TOC (ft)	Groundwater Elevation (MSL) (ft)
11	03/24/03	Alluvial	17-21.5	21.50	4.00	346.00		NG	NA
	10/21/92							7.47	342.53
	10/17/90							7.44	342.56
	03/22/90							5.15	344.85
	04/02/87							NA	340.80
11X	03/24/03	Alluvial	17-22	22.00	5.93	346.00		NG	NA
	10/21/92							7.40	344.53
	10/17/90							7.28	344.65
	03/22/90							5.00	346.93
12	-				NA			Well Destroyed	
	04/02/87	Alluvial	14.5-19.5	19.50			DNAPL		340.38
13	03/24/03	Alluvial	14.5-19.5	19.50	3.38	347.00		NG	NA
	01/14/02							7.58	342.80
	10/21/92							5.07	345.31
	10/17/90							5.06	345.32
	03/22/90							5.69	344.69
14	04/02/87						DNAPL	NA	340.51
	-	Alluvial	14.5-19.5	19.50	NA			Well Destroyed	
15	04/02/87						DNAPL		339.40
	03/24/03	Alluvial	13-18	20.15 (?)	4.13	342.00		5.77	340.36
	07/11/02							20.15	325.98
	01/14/02							6.80	339.33
	10/21/92							4.98	341.15
	10/17/90							3.22	340.51
16	03/22/90							7.00	340.51
	04/02/87						DNAPL	NA	338.50
	03/24/03	Alluvial	12-17	17.00	2.75	342.00	-10.00	6.29	338.46
	07/10/02							8.29	336.46
	01/14/02							7.25	337.50
	05/17/01							8.28	336.47
	10/21/92							5.15	339.60
	10/17/90							5.06	339.69
16	03/22/90						DNAPL	2.73	340.51
	04/02/87						DNAPL	NA	338.10

Table 2
Historical Potentiometric Surface Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
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Well Data							Potentiometric Data		
Well ID	Date Gauged	Aquifer	Screen Interval (ft bgs)	Well Depth (ft bgs)	Height of TOC AGS (ft)	Ground Surface Elevation (ft)	DNAPL Thickness (ft)	Depth to Water from TOC (ft)	Groundwater Elevation (MSL) (ft)
17	03/24/03	Alluvial	9.5-14.5 (r)	17.45 (r)	3.30	342.00	-9.00	5.58	339.72
	-9.50						8.50	336.80	
	-9.45						6.50	335.50	
							4.45	340.85	
							4.36	340.94	
	03/22/90						2.15	340.51	
	04/02/87						DNAPL	NA	338.57
18	03/24/03	Fort Pillow	134-154	154.00	3.18	344.00		NG	NA
							5.54	341.64	
							5.49	341.69	
							3.38	343.80	
							NA	339.33	
18S	03/24/03	Alluvial	20-30	30.00	2.39	342.00		5.55	338.84
							7.18	337.21	
							6.49	337.90	
							7.54	336.85	
19M	03/24/03	Fort Pillow	50-60	60.00	2.28	342.00		5.21	339.07
							7.50	336.78	
							6.15	338.13	
							7.22	337.06	
20S	03/24/03	Alluvial	20-30	30.00	2.70	342.00	-3.50	5.53	339.17
							7.50	337.20	
							6.60	338.10	
							7.56	337.14	
20M	03/24/03	Fort Pillow	50-60	60.00	2.53	342.00		5.14	339.39
							7.14	337.39	
							6.17	336.36	
							7.11	337.42	

Table 2
Historical Potentiometric Surface Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
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Well Data							Potentiometric Data		
Well ID	Date Gauged	Aquifer	Screen Interval (ft bgs)	Well Depth (ft bgs)	Height of TOC AGS (ft)	Ground Surface Elevation (ft)	DNAPL Thickness (ft)	Depth to Water from TOC (ft)	Groundwater Elevation (MSL) (ft)
OSGW 1-1	03/24/03	Alluvial	13-18	18 00	4 15	343.00		NG	NA
	07/08/02							10 48	336 67
	01/14/02							9 24	337 91
	05/17/01							10 39	336 76
	10/21/92							5 63	341 52
OSGW 1-2	03/24/03	Alluvial	19-24	24 00	4 20	343 00		NG	NA
	07/08/02							9 98	337 22
	01/14/02							8 83	338 37
	05/17/01							9 64	337 56
	10/21/92							5 20	342 00
OSGW 1-3	03/24/03	Alluvial	27-32	32 00	4 37	343 00		NG	NA
	07/08/02							10 50	336 87
	01/14/02							9 35	338 02
	05/17/01							10 46	336 91
	10/21/92							5 57	341 80
OSGW 1-4	03/24/03	Fort Pillow	42-52	52 00	4 18	343 00		NG	NA
	07/08/02							9 89	337 29
	01/14/02							8 70	338 48
	05/17/01							9 88	337 30
	10/21/92							5 25	341 93
OSGW 1-5	03/24/03	Fort Pillow	92-102	102 00	4 41	343.00		NG	NA
	07/08/02							10 50	336 91
	01/14/02							9 33	338 08
	05/17/01							10 48	336 93
	10/21/92							5 53	341 88
OSGW 1-6	03/24/03	Fort Pillow	128-138	138 00	4 42	343 00		NG	NA
	07/08/02							10 21	337 21
	01/14/02							9 07	338 35
	05/17/01							10 21	337 21
	10/21/92							5 26	342 16

Table 2
Historical Potentiometric Surface Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
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Well Data							Potentiometric Data		
Well ID	Date Gauged	Aquifer	Screen Interval (ft bgs)	Well Depth (ft bgs)	Height of TOC AGS (ft)	Ground Surface Elevation (ft)	DNAPL Thickness (ft)	Depth to Water from TOC (ft)	Groundwater Elevation (MSL) (ft)
OSGW 2-1	03/24/03	Alluvial	10-15	15.00	4.16	342.00		NG	NA
	07/08/02							10.89	335.27
	01/14/02							9.44	336.72
	05/17/01							10.75	335.41
	10/21/92							6.27	339.89
OSGW 2-2	03/24/03	Alluvial	17-22	22.00	4.32	342.00		NG	NA
	07/08/02							11.00	335.32
	01/14/02							9.60	336.72
	05/17/01							10.87	335.45
	10/21/92							5.92	340.40
OSGW 2-3	03/24/03	Alluvial	24-29	29.00	4.42	342.00		NG	NA
	07/08/02							10.48	335.94
	01/14/02							9.13	337.29
	05/17/01							10.37	336.05
	10/21/92							5.75	340.67
OSGW 2-4	03/24/03	Fort Pillow	62-72	72.00	4.51	342.00		NG	NA
	07/08/02							10.64	335.87
	01/14/02							9.36	337.15
	05/17/01							10.57	335.94
	10/21/92							5.42	341.09
OSGW 2-5	03/24/03	Fort Pillow	92-102	102.00	4.66	342.00		NG	NA
	07/08/02							10.68	335.98
	01/14/02							9.46	337.20
	05/17/01							10.59	336.07
	10/21/92							4.88	341.78
OSGW 2-6	03/24/03	Fort Pillow	127-137	137.00	4.25	342.00		NG	NA
	07/08/02							10.46	335.79
	01/14/02							9.27	336.98
	05/17/01							10.38	335.87
	10/21/92							5.30	340.95

Table 2

Well Data							Potentiometric Data		
Well ID	Date Gauged	Aquifer	Screen Interval (ft bgs)	Well Depth (ft bgs)	Height of TOC ACS (ft)	Ground Surface Elevation (ft)	DNAPL Thickness (m)	Depth to Water from TOC (ft)	Groundwater Elevation (MSL) (ft)
OSGW 3-1	03/24/03	Alluvial	9-14	14.00	4.35	341.00		9.28	336.07
	07/08/02							11.65	333.70
	01/14/02							10.17	335.18
	05/17/01							11.55	333.80
	10/21/92							6.80	338.55
OSGW 3-2	03/24/03	Alluvial	15-20	20.00	4.38	341.00		9.78	335.60
	07/08/02							12.14	333.24
	01/14/02							10.65	334.73
	05/17/01							12.06	333.32
	10/21/92							7.25	338.13
OSGW 3-3	03/24/03	Alluvial	24-29	29.00	4.20	341.00		9.71	335.49
	07/08/02							12.05	333.15
	01/14/02							10.63	334.57
	05/17/01							11.94	333.26
	10/21/92							7.43	337.77
OSGW 3-4	03/24/03	Fort Pillow	36-46	46.00	4.64	341.00		9.98	335.66
	07/08/02							12.29	333.35
	01/14/02							10.81	334.83
	05/17/01							12.19	333.45
	10/21/92							7.25	338.39
OSGW 3-5	03/24/03	Fort Pillow	68-78	78.00	4.58	341.00		NG	NA
	07/08/02							10.92	334.66
	01/14/02							9.67	335.91
	05/17/01							10.77	334.81
	10/21/92							5.85	339.73
OSGW 3-6	03/24/03	Fort Pillow	138-148	148.00	4.66	341.00		NG	NA
	07/08/02							10.59	335.07
	01/14/02							9.45	336.21
	05/17/01							10.49	335.17
	10/21/92							5.50	340.16

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Well Data										Potentiometric Data		
Well ID	Date Gauged	Aquifer	Screen Interval (ft bgs)	Well Depth (ft bgs)	Height of TOC AGS (ft)	Ground Surface Elevation (ft)	DNAPL Thickness (ft)	Depth to Water from TOC (ft)	Groundwater Elevation (MSL) (ft)			
OSGW 4-1	03/24/03	Alluvial	10-15	15.00	4 22	343.00		10.45	336.77			
	07/08/02							13 85	333.37			
	01/14/02							12 71	334.51			
	05/17/01							13 74	333 48			
	10/21/92							9 44	337.78			
OSGW 4-2	03/24/03	Alluvial	22-27	27 00	4 25	343 00		11 00	336.25			
	07/08/02							14 40	332 85			
	01/14/02							13 20	334.05			
	05/17/01							14 30	332.95			
	10/21/92							9 79	337 46			
OSGW 4-3	03/24/03	Alluvial	36-41	41.00	3 91	343	Well Destroyed					
	07/08/02							14.00	332 91			
	01/14/02							12 88	334.03			
	05/17/01							13 88	333.03			
	10/21/92							13.88	333.03			
OSGW 4-4	03/24/03	Fort Pillow	48-58	58.00	4 25	343.00		10.10	337.15			
	07/08/02							13.29	333 96			
	01/14/02							12 13	335.12			
	05/17/01							13.15	334 10			
	10/21/92							8 52	338 73			
OSGW 4-5	03/24/03	Fort Pillow	79-89	89.00	4 15	343 00		NG	NA			
	07/08/02							12 75	334 40			
	01/14/02							11 55	335 60			
	05/17/01							12.59	334.56			
	10/21/92							8.04	339 11			
OSGW 4-6	03/24/03	Fort Pillow	117-127	127.00	4 34	343 00		NG	NA			
	07/08/02							11 93	335.41			
	01/14/02							10.74	336 60			
	05/17/01							11 76	335.58			
	10/21/92							6 73	340 61			

Table 2
Historical Potentiometric Surface Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
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Well Data							Potentiometric Data		
Well ID	Date Gauged	Aquifer	Screen Interval (ft bgs)	Well Depth (ft bgs)	Height of TOC AGS (ft)	Ground Surface Elevation (ft)	DNAPL Thickness (ft)	Depth to Water from TOC (ft)	Groundwater Elevation (MSL) (ft)
OSGW 5-1	03/24/03	Alluvial	12-17	17.00	3.95	342.00		NG	NA
	07/08/02						11.24	334.71	
	01/14/02						10.15	335.80	
	05/17/01						11.11	334.84	
	10/21/92						6.75	339.20	
OSGW 5-2	03/24/03	Alluvial	19-24	24.00	4.40	342.00		NG	NA
	07/08/02						11.73	334.67	
	01/14/02						10.62	335.78	
	05/17/01						11.62	334.78	
	10/21/92						6.75	339.65	
OSGW 5-3	03/24/03	Alluvial	27-32	32.00	4.30	342.00		NG	NA
	07/08/02						11.60	334.70	
	01/14/02						10.48	335.82	
	05/17/01						11.48	334.82	
	10/21/92						6.80	339.50	
OSGW 5-4	03/24/03	Alluvial	40-50	50.00	4.50	342.00		NG	NA
	07/08/02						11.31	335.19	
	01/14/02						10.19	336.31	
	05/17/01						11.20	335.30	
	10/21/92						6.47	340.03	
OSGW 5-5	03/24/03	Fort Pillow	83-93	93.00	4.35	342.00		NG	NA
	07/08/02						11.15	335.20	
	01/14/02						10.03	336.32	
	05/17/01						11.06	335.29	
	10/21/92						6.01	340.34	
OSGW 5-6	03/24/03	Fort Pillow	113-123	123.00	4.21	342.00		NG	NA
	07/08/02						10.80	335.41	
	01/14/02						9.68	336.53	
	05/17/01						10.70	335.51	
	10/21/92						5.73	340.48	

Table 2
Historical Potentiometric Surface Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
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Well Data										Potentiometric Data		
Well ID	Date Gauged	Aquifer	Screen Interval (ft bgs)	Well Depth (ft bgs)	Height of TOC AGS (ft)	Ground Surface Elevation (ft)	DNAPL Thickness (ft)	Depth to Water from TOC (ft)	Groundwater Elevation (MSL) (ft)			
OSGW 6-1	03/24/03	Alluvial	10-15	15.00	4.00	342.00		NG	NA			
	11.02							334.98				
	10.10							335.90				
	10.98							335.02				
	6.40							339.60				
OSGW 6-2	03/24/03	Alluvial	19-24	24.00	3.87	342.00		NG	NA			
	11.05							334.82				
	10.10							335.77				
	10.99							334.88				
	6.21							339.66				
OSGW 6-3	03/24/03	Alluvial	27-32	32.00	3.87	342.00		NG	NA			
	11.18							334.69				
	10.28							335.59				
	11.10							334.77				
	6.38							339.49				
OSGW 6-4	03/24/03	Fort Pillow	50-60	60.00	4.25	342.00		NG	NA			
	11.25							335.00				
	10.16							336.09				
	11.14							335.11				
	6.00							340.25				
OSGW 6-5	03/24/03	Fort Pillow	82-92	92.00	3.90	342.00		NG	NA			
	11.45							334.45				
	10.40							335.50				
	11.41							334.49				
	6.40							339.50				
OSGW 6-6	03/24/03	Fort Pillow	120-130	130.00	4.25	342.00		NG	NA			
	11.28							334.97				
	10.14							336.11				
	11.13							335.12				
	6.20							340.05				

NOTES

NG - Not Gauged, NA - Not Available, BGS - Below Ground Surface, TOC - Top of Casing

DNAPL-Dense Non Aqueous Phase Liquid (Creosote) Detected in well, but thickness is not known

Table 3
Historical Groundwater Analytical Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
(Page 1 of 9)

Sample Information		VOCs			PAHs								PCPs	SUM of VOCs			SUM of PAHs			SUM of PCPs
Monitoring Well ID	Sample Date	Benzene	1,2,4-Trimethylbenzene	Vinyl Chloride	Acenaphthene	Benzo (a) anthracene	Benzo (b) Fluoranthene	Benzo (k) Fluoranthene	Benzo (a) pyrene	Chrysene	Fluoranthene	Fluorene	Naphthalene	Pyrene	Dibenzofuran	Pentachlorophenol				
1S	MCLs for Tap Water (µg/L)	5	NA	2	NA	NA	NA	NA	0.2	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	
	Region IX PRGs (µg/L)	0.34	12	0.02	370	0.092	0.092	0.92	0.0092	9.2	1500	240	6.2	180	24	0.58	NA	NA	NA	
	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	
	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	
	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	
	03/24/03	10	5.2	<5.0	77	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	29	150	<10.0	32	<10.0	15.2	288	<10.0	
	07/12/02	<50	<50	<50	210	<100	<100	<100	<100	<100	<100	<100	890	<100	<100	<50	1,100.0	<100		
	01/17/02	<250	<250	<250	330	<200	<200	<200	<200	<200	<200	<200	2,400	<200	<200	<250	2,730.0	<200		
	05/17/01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2,160	ND	ND	ND	ND	ND	ND	
	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	
2M	03/24/03	18	12	<5.0	67	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	29	1,200	<10.0	41	100	30.0	1,337.0	100.0	
	07/12/02	<250	<250	<250	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	3,500	<1000	<1000	<1000	<250	3,500.0	<1000	
	01/17/02	<250	<250	<250	<200	<200	<200	<200	<200	<200	<200	<200	3,000	<200	<200	<250	3,000.0	<200		
	05/17/01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2,340	ND	ND	320	ND	2,340.0	320.0	
	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	91.1	585.5	556.5	
2D	03/24/03	<1.0	<1.0	<1.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<1.0	<10.0	<10.0	
	07/12/02	<1.0	<1.0	<1.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<1.0	<10.0	<10.0	
	01/17/02	<1.0	<1.0	<1.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<1.0	<10.0	<10.0	
	05/17/01	<1.0	<1.0	<1.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<1.0	<10.0	<10.0	
	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	

Table 3
Historical Groundwater Analytical Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
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Sample Information		VOCs			PAHs								PCPs		SUM of VOCs	SUM of PAHs	SUM of PCPs
Monitoring Well ID	Sample Date	Benzene	1,2,4-Trimethylbenzene	Vinyl Chloride	Acenaphthene	Benzo (a) anthracene	Benzo (b) Fluoranthene	Benzo (k) Fluoranthene	Benzo (a) pyrene	Chrysene	Fluoranthene	Fluorene	Naphthalene	Pyrene	Dibenzofuran	Pentachlorophenol	
MCLs for Tap Water (µg/L)		5	12	2	370	0.092	0.092	0.92	0.0092	9.2	1500	240	6.2	180	24	1	NA
Region IX PRGs (µg/L)		0.34	0.02	0.02	370	0.092	0.092	0.92	0.0092	9.2	1500	240	6.2	180	24	0.56	NA
3S	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3M	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3D	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4S	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4M	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4D	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5S	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5M	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5D	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	Jan 87-Oct 88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10X		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3
Historical Groundwater Analytical Data
American Creosote Works TDEC-DBF Site No. 57-508
Jackson, Tennessee
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[illegible]

Table 3
Historical Groundwater Analytical Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
(Page 4 of 9)

Sample Information		VOCs			PAHs									PCPs					
Monitoring Well ID	Sample Date	Benzene	1,2,4-Trimethylbenzene	Vinyl Chloride	Acenaphthene	Benzo (a) anthracene	Benzo (b) Fluoranthene	Benzo (k) Fluoranthene	Benzo (a) pyrene	Chrysene	Fluoranthene	Fluorene	Naphthalene	Pyrene	Dibenzofuran	Pentachlorophenol	SUM of VOCs	SUM of PAHs	SUM of PCPs
19S	MCLs for Tap Water (µg/L)	5	12	2	370	0.092	0.092	0.92	0.0092	9.2	1500	240	6.2	180	24	1	NA	NA	NA
	Region IX PRGs (µg/L)	0.34														0.56	NA	NA	NA
	03/24/03	<1.0	<1.0	<1.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<1.0	<10.0	<10.0
	07/12/02	<1	<1	<1	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<1	<10.0	<10.0
	01/17/02	<1	<1	<1	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<1	<10.0	<10.0
19M	05/17/01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	19	ND	ND	ND	ND	ND	ND
	03/24/03	<1.0	<1.0	<1.0	10	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<1.0	10.0	<10.0
	07/12/02	<1	<1	<1	17	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	42	<10.0	10	<10.0	<1	89.0	<10.0
	01/17/02	<1	<1	<1	17	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	14	39	<10.0	<10.0	<1	70.0	29.0	
	05/17/01	ND	ND	ND	23	ND	ND	ND	ND	ND	ND	17	38	ND	13	ND	ND	91.0	ND
20S	03/24/03	73	94	<50.0	2,800	480	300	140	180	420	2,500	1,800	3,700	1,800	1,800	4,400	167.0	15,900.0	4,400.0
	07/12/02	86	<50	<50	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	1,900	<1000	<1000	5,800	86.0	1,900.0	5,800.0
	01/17/02	<25	<25	<25	<500	<500	<500	<500	<500	<500	<500	<500	1,300	<500	<500	3,800	<25	1,300.0	3,800.0
	05/17/01	ND	ND	ND	969	ND	ND	ND	ND	ND	ND	ND	1,980	ND	510	4,950	ND	3,469.0	4,950.0
	03/24/03	<1.0	<1.0	<1.0	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<1.0	<10	<10
20M	07/12/02	<1.0	<1.0	<1.0	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<1.0	<10	<10
	01/17/02	<25	<25	<25	21	<10	<10	<10	<10	<10	<10	11	33	<10	11	22	<25	65	22
	05/17/01	ND	ND	ND	15	ND	ND	ND	ND	ND	ND	ND	10	ND	ND	ND	ND	25	ND

Table 3
Historical Groundwater Analytical Data
American Croosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
(Page 5 of 9)

[illegible]

Table 3
Historical Groundwater Analytical Data
American Crosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
(Page 6 of 9)

Sample Information		VOCs			PAHs									PCPs	SUM of VOCs			SUM of PAHs			SUM of PCPs		
Monitoring Well ID	Sample Date	Benzene	1,2,4-Trimethylbenzene	Vinyl Chloride	Acenaphthene	Benzo (a) anthracene	Benzo (b) Fluoranthene	Benzo (k) Fluoranthene	Benzo (a) pyrene	Chrysene	Fluoranthene	Fluorene	Naphthalene	Pyrene	Dibenzofuran	Pentachlorophenol							
OSGW 3-1	MCLs for Tap Water (µg/L)	5	NA	2	NA	NA	NA	NA	0.2	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA			
	Region IX PRGs (µg/L)	0.34	12	0.02	370	0.092	0.092	0.92	0.0092	9.2	1500	240	6.2	180	24	0.56	NA	NA	NA	NA			
	03/24/03	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0			
	07/12/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
	01/17/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
OSGW 3-2	05/17/01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
	03/24/03	<1.0	<1.0	<1.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0			
	07/12/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
	01/17/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
	05/17/01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
OSGW 3-3	03/24/03	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0			
	07/12/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
	01/17/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
	05/17/01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
	03/24/03	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0			
OSGW 3-4	07/12/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
	01/17/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
	05/17/01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
	03/24/03	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0			
	07/12/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
OSGW 3-5	01/17/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
	05/17/01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
	03/24/03	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0			
	07/12/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
	01/17/02	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0			
OSGW 3-6	05/17/01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
	03/24/03	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0			

Table 3
Historical Groundwater Analytical Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
(Page 7 of 9)

[illegible]

Table 3
Historical Groundwater Analytical Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
(Page 8 of 9)

[illegible]

Table 3
Historical Groundwater Analytical Data
American Creosote Works TDEC-DSF Site No. 57-508
Jackson, Tennessee
 (Page 9 of 9)

Sample Information		VOCs			PAHs								PCPs		SUM of VOCs	SUM of PAHs	SUM of PCPs
Monitoring Well ID	Sample Date	Benzene	1,2,4-Trimethylbenzene	Vinyl Chloride	Acenaphthene	Benzo (a) anthracene	Benzo (b) Fluoranthene	Benzo (k) Fluoranthene	Benzo (a) pyrene	Chrysene	Fluoranthene	Fluorene	Naphthalene	Pyrene	Dibenzofuran	Pentachlorophenol	
MCLs for Tap Water (µg/L)		5	12	2	370	0.092	0.092	0.92	0.0092	9.2	1500	240	6.2	180	24	1	NA
Region IX PRGs (µg/L)		0.34		0.02												0.56	NA
OSGW 6-1	10/01/92	0.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSGW 6-2	10/01/92	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSGW 6-3	10/01/92	0.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSGW 6-4	10/01/92	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSGW 6-5	10/01/92	0.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSGW 6-6	01/01/93	<0.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	10/01/92	0.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES: NA - Not Available, ND - Not Detected (below laboratory detection limits), NS - Not Sampled
 All concentrations presented in micrograms per liter (µg/L) or parts-per-billion (ppb)
 Utilized the October 1, 2002 EPA Region IX Preliminary Remediation Goals (PRGs)
 Bold cells indicates that concentration exceeds the Maximum Contaminant Levels (MCLs) for Tap Water
 Shaded cells indicates that concentration exceeds the Region IX PRGs for Tap Water
 Sum of Volatile Organic Compounds (VOCs), derived from SAME Final RI, 1998
 Sum of Polynuclear Aromatic Hydrocarbons (PAHs) derived from SAME Final RI, 1998
 Sum of Pentachlorophenol (PCPs) derived from SAME Final RI, 1998

LEGEND

- 20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- L3 LAGOON (INFERRED) BOUNDARIES

REFERENCE:

STATE FINAL RL 1988 (FGS4-3A, 4-4, 4-5)
U.S.G.S. WEIR #93-4170
OWB (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1999 (INFERRED CAP LOCATION),
TABLE 1



Shaw

242 MORTGAGE PARK DRIVE
SUITE 102
MEMPHIS, TN 37129
(915) 867-1800
Shaw Environmental, Inc.

REV. NO.: DRAWING DATE: 3-22-04 ACAD FILE: 4304812

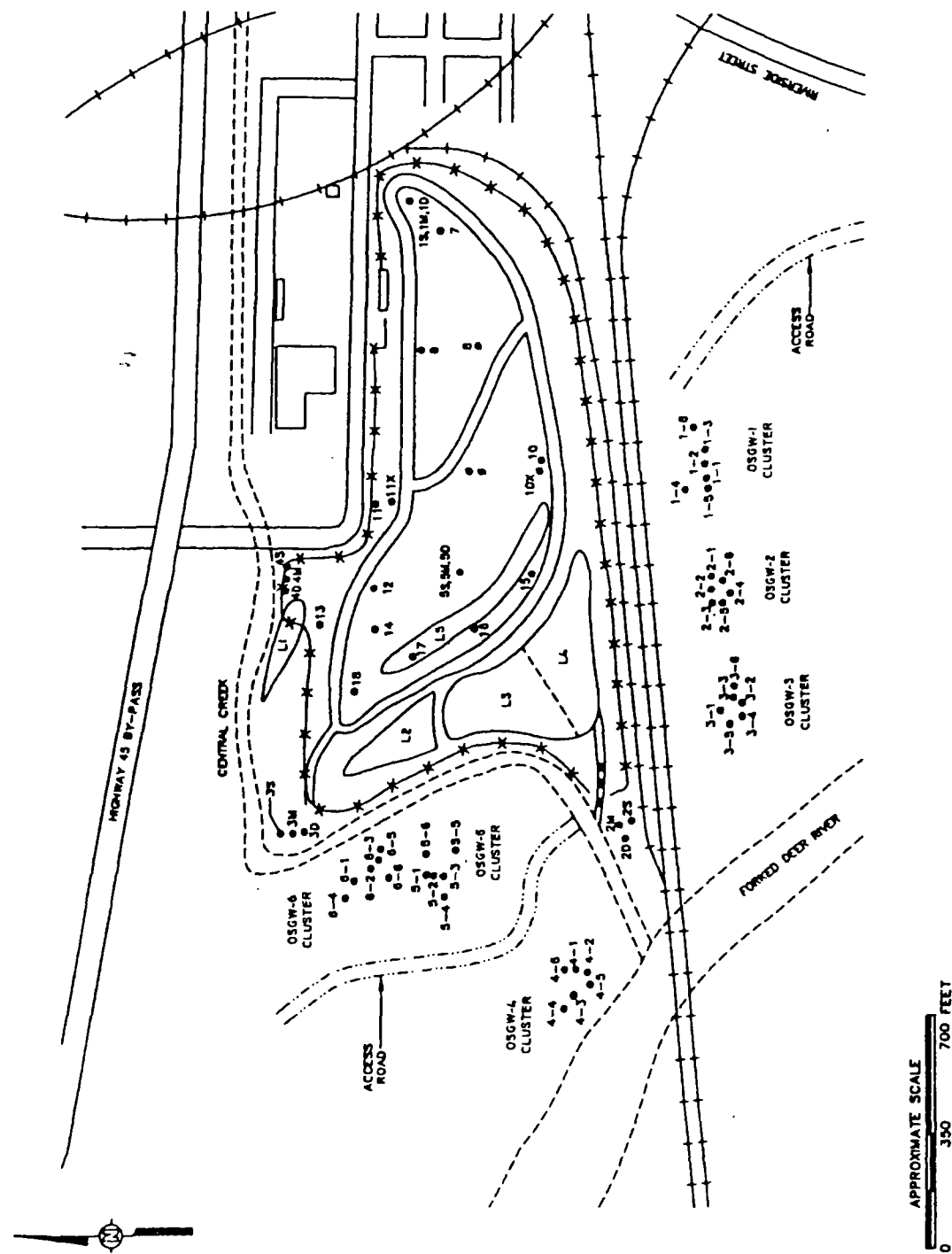
SITE MAP
PRE-SOLIDIFICATION (STABILIZATION
AND CAP INSTALLATION)

CLIENT: AMERICAN CREOSOTE WORKS
TDSF No. 97-508

LOCATION: JACKSON TENNESSEE

DESIGNED: DETAILED PROJECT NO.: 834304

DS DSUF 1



APPROXIMATE SCALE
0 350 700 FEET

LEGEND

- 20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- 12 X DESTROYED MONITORING WELL CLUSTERS (INCLUDING 5S, 3M, 50, POSSIBLY 1S, 1M, 10)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- L3 LAGOON (INFERRED) BOUNDARIES

REFERENCE:

U.S.G.S. WRR #93-4170
OHM (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1999 (INFERRED CAP LOCATION)



242 HERITAGE PARK DRIVE
SUITE 102
MURFREESBORO, TN 37129
(615) 847-1805

REV. NO.: DRAWING DATE: ROAD FILE: 4304813

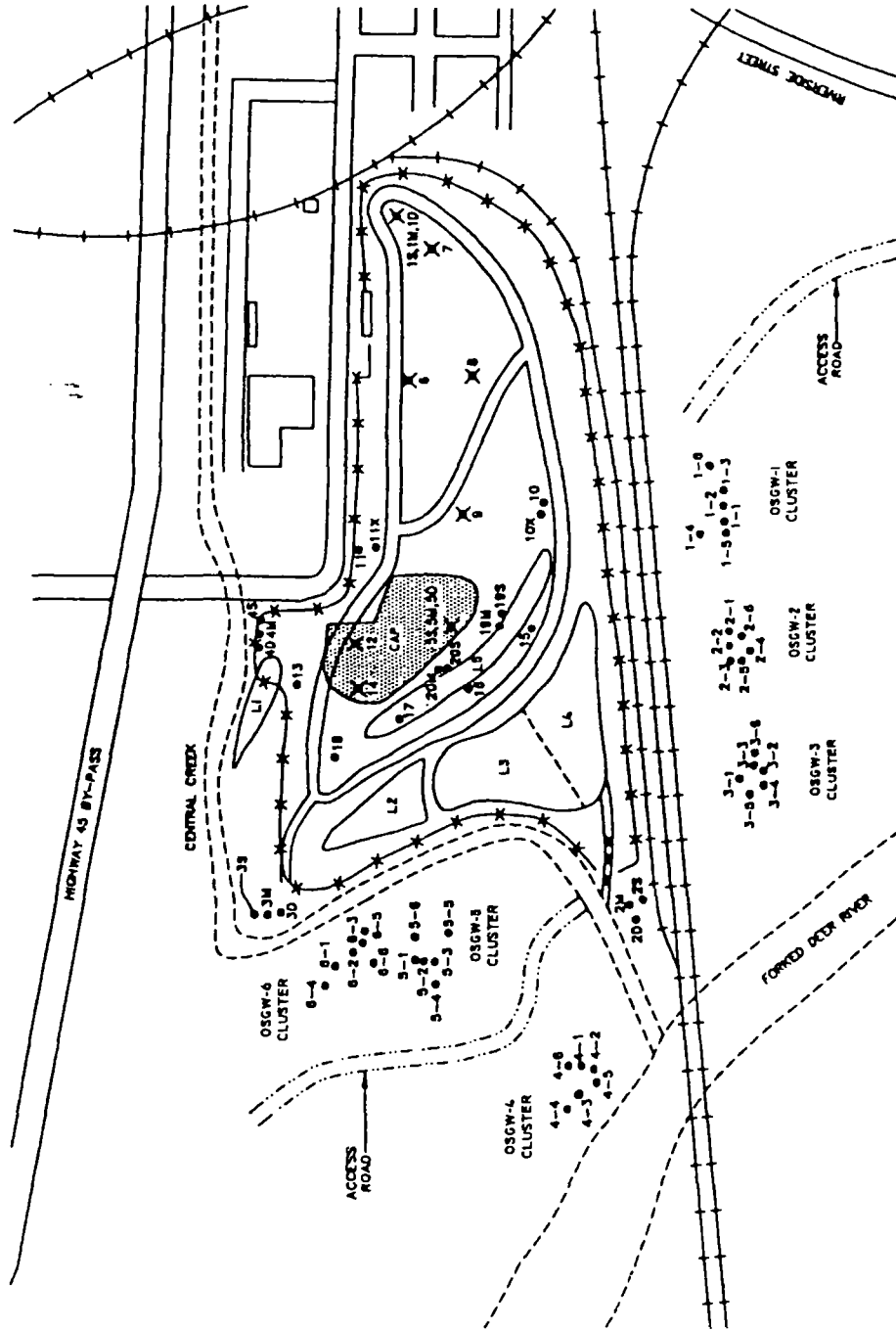
SITE MAP
POST-SOLIDIFICATION (STABILIZATION
AND CAP INSTALLATION)

CLIENT: AMERICAN CREOSOTE WORKS
TDSF No. 57-508

LOCATION: JACKSON TENNESSEE

DESIGNED: SDJF PROJECT NO.: 834304

PL/RC: DS
KIR
FOUR: 2



APPROXIMATE SCALE
0 350 700 FEET

LEGEND

20M	MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
HAB-1	SOIL BORING LOCATION
---	STREAM
---	RAILROAD
---	FENCE
---	DRAINAGE CULVERT
L3	LAGOON (INFERRED) BOUNDARIES
0.006	VOC CONCENTRATION (ppm)
9.92	PAH CONCENTRATION (ppm)
ND	PCP CONCENTRATION (ppm)
NA	NOT AVAILABLE
ND	NON-DETECT BELOW LABORATORY DETECTION LIMITS

REFERENCE

SAME FINAL RI, 1986 (FIGS 4-3A, 4-4, 4-5)
U.S.G.S. WRIIR #93-4170
OHM (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1989 (INFERRED CAP LOCATION),
TABLE 1

242 HERITAGE PARK DRIVE
SUITE 102
MURFREESBORO, TN 37129
(615) 847-1005



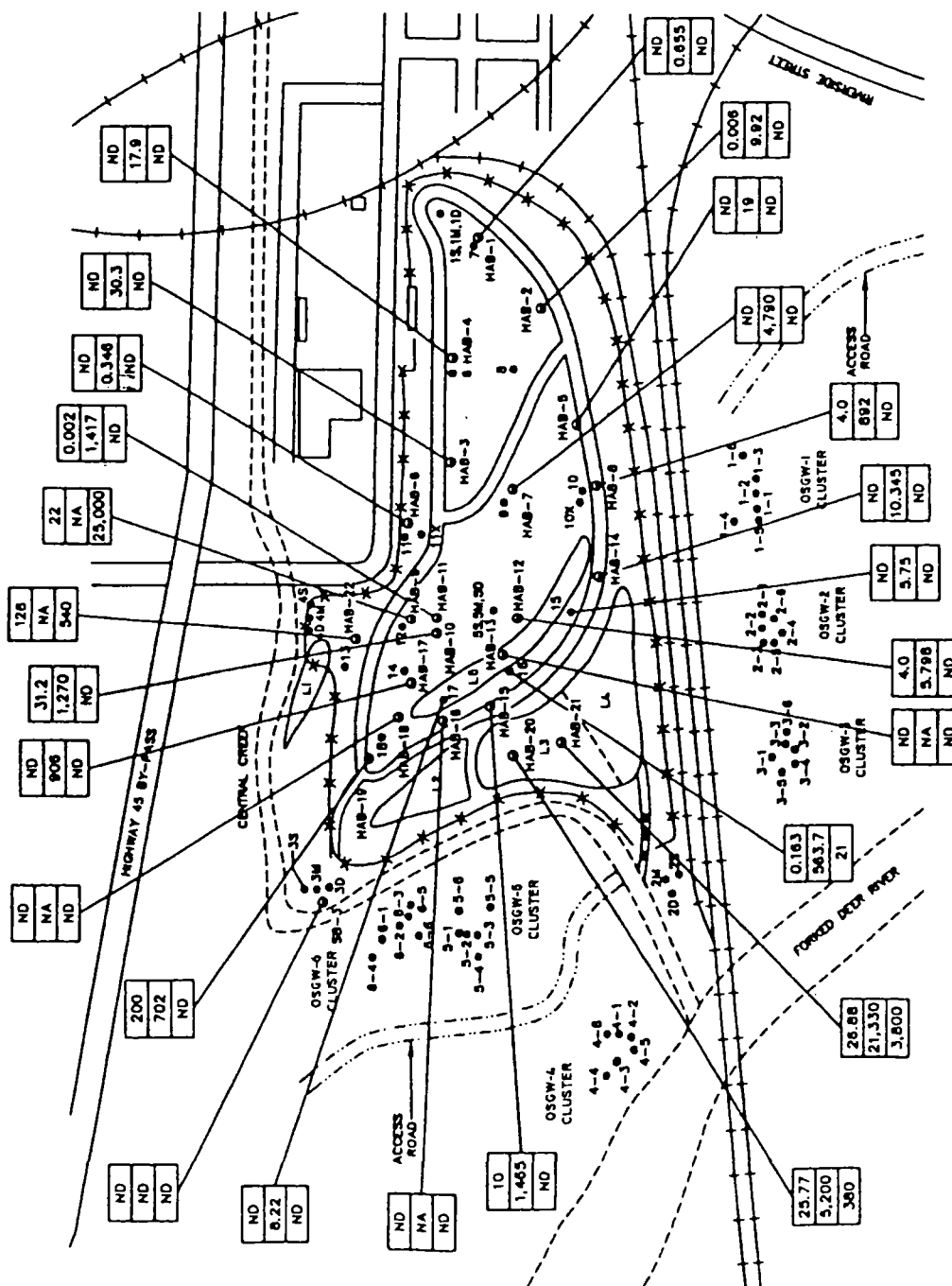
REV. NO.: DRAWING DATE: 3-23-04 ACAD FILE: 4304814

SOIL SAMPLE LOCATION MAP
SUM OF VOC, PAH AND PCP
CONCENTRATIONS (0 TO 5' BGS)
JANUARY 87 AND OCTOBER 88

CLIENT: AMERICAN CREOSOTE WORKS
TDSF No. 57-308

LOCATION: JACKSON TENNESSEE

DESIGNED: DS
CHECKED: SDJF
PROJECT NO.: 834304
FIGURE: 3



APPROXIMATE SCALE
0 350 700 FEET

LEGEND

20' ●	MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
MAB-1 ●	SOIL BORING LOCATION
---	STREAM
---	RAILROAD
---	FENCE
---	DRAINAGE CULVERT
L3	LAGOON (INFERRED) BOUNDARIES
0.008	VOC CONCENTRATION (ppm)
9.92	PAH CONCENTRATION (ppm)
ND	PCP CONCENTRATION (ppm)
NA	NOT AVAILABLE
ND	NON-DETECT BELOW LABORATORY DETECTION LIMITS

REFERENCE:

STATE FINAL RI, 1988 (RCS4-JA, 4-4, 4-5)
U.S.G.S. WRIIR #93-4170
OHM (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1999 (INFERRED CAP LOCATION),
TABLE 1

242 MORTGAGE PARK DRIVE
SUITE 102
MEMPHIS, TN 37129
(901) 667-1000



REV. NO.: DRAWING DATE: 3-23-04 ACAD FILE: 4304816

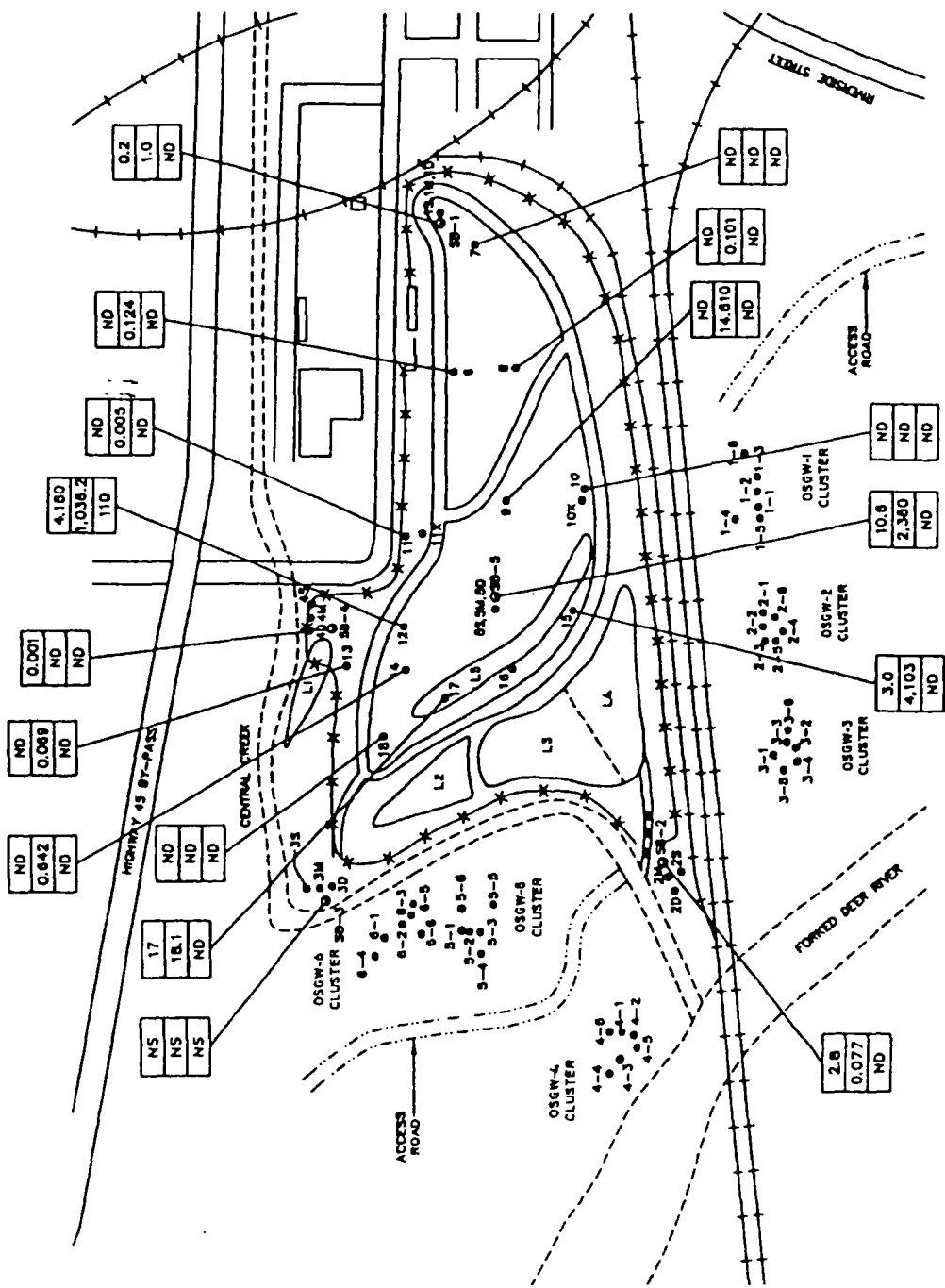
SOIL SAMPLE LOCATION MAP
SUM OF VOC, PAH AND PCP
CONCENTRATIONS (15 TO 25' BGS)
JANUARY 87 AND OCTOBER 88

CLIENT: AMERICAN CREOSOTE WORKS
TOSF No. 57-508

LOCATION: JACKSON TENNESSEE

DESIGNED: DS SDJF PROJECT NO.: 834304

FIGURE: 5



APPROXIMATE SCALE
0 350 700 FEET

LEGEND

- 20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- 12 ✕ DESTROYED MONITORING WELL CLUSTERS (INCLUDING 5S, 5M, 5O, POSSIBLY 1S, 1M, 1O)
- STREAM
- RAILROAD
- FENCE
- CP-1 ● GEOPROBE POINT
- ▨ SOIL ASSESSMENT AREA (GEOPROBED AREA)
- 5-7 VOC CONCENTRATION (ppm)
- 0.008 PAH CONCENTRATION (ppm)
- 8.92 PCP CONCENTRATION (ppm)
- ND NON-DETECT BELOW LABORATORY DETECTION LIMITS
- ▨ FREE PHASE CREOSOTE

REFERENCE

STATE FINAL RI, 1988 (FIGS 4-3A, 4-4, 4-5)
U.S.G.S. WRR #93-4170
OHM (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1988 (INFERRED CAP LOCATION),
TABLE 1

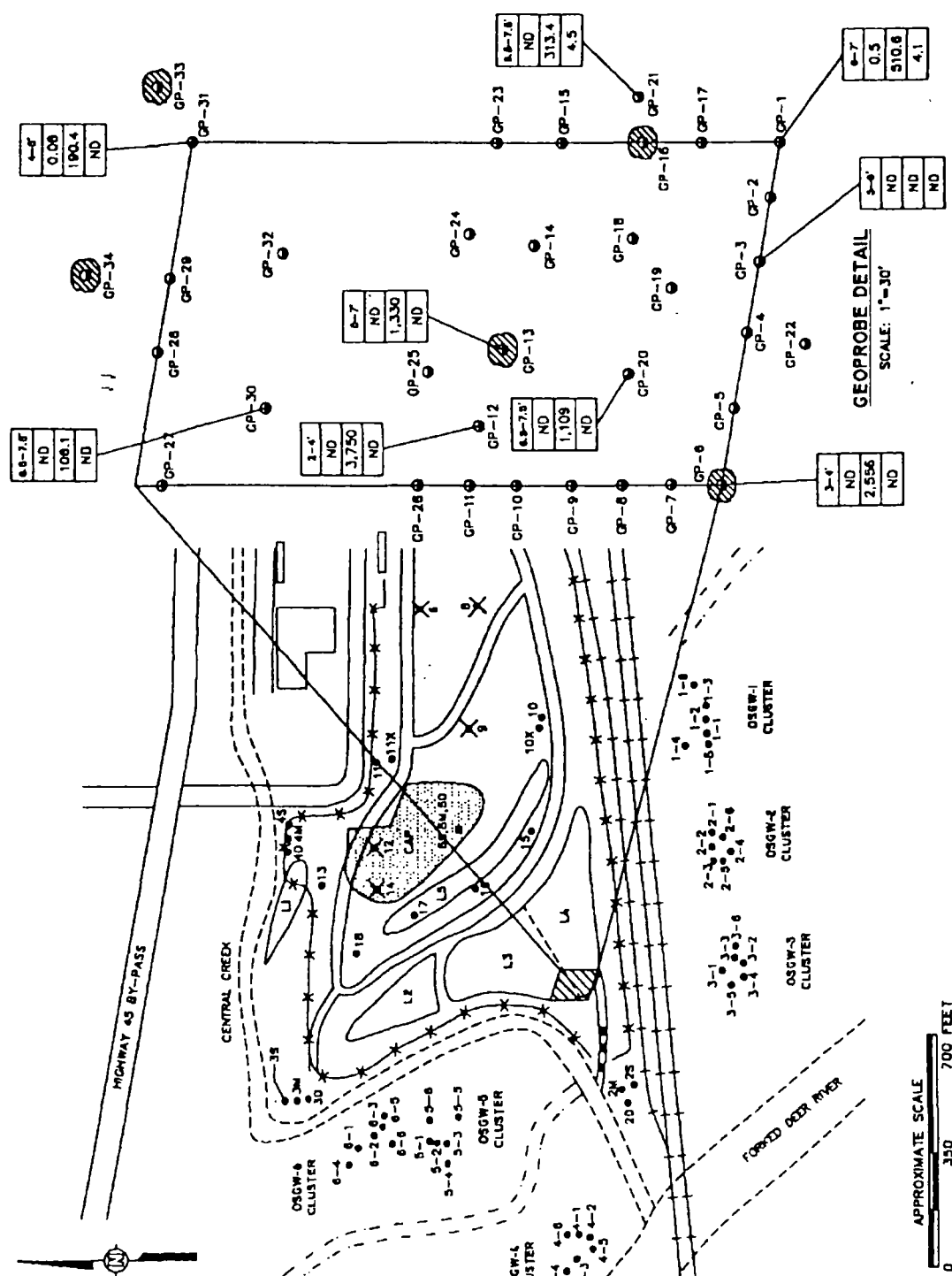


242 HERITAGE PARK DRIVE
SUITE 102
MURFREESBORO, TN 37129
(615) 887-1805
Shaw Environmental, Inc.

REV. NO.: DRAWING DATE: 3-23-04 ACAD FILE: 4304B17

SOIL SAMPLE LOCATION MAP SUM OF VOC, PAH AND PCP CONCENTRATIONS (2-8' BGS) JULY 2002

CLIENT:	AMERICAN CREOSOTE WORKS	PM:	DS
LOCATION:	JACKSON TENNESSEE	PL/RG:	KR
DESIGNED:	DS	PROJECT NO.:	834304
DETAILED:	SDJF	FIGURE:	8



GEOPROBE DETAIL SCALE: 1"=30'



LEGEND

- MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- LAGOON (INFERRED) BOUNDARIES
- GROUNDWATER ELEVATION (FEET)
- GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- FREE PHASE CREOSOTE (DNAPL) DETECTED IN WELLS 55, 9, 10, 12, 13, 14, 15, 16 and 17

REFERENCE:

SAME FINAL, 1988 (FGS4-3A, 4-4, 4-5)
U.S.G.S. WRIR #93-4170
OHM (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1999 (INFERRED CAP LOCATION),
TABLE 1



242 HERITAGE PARK DRIVE
SUITE 102
MARTINESSBORO, TN 37129
(615) 887-1800

REV. NO.: DRAWING DATE: 3-23-04 ACAD FILE: 4304818

POTENTIOMETRIC SURFACE MAP

ALLUVIAL AQUIFER

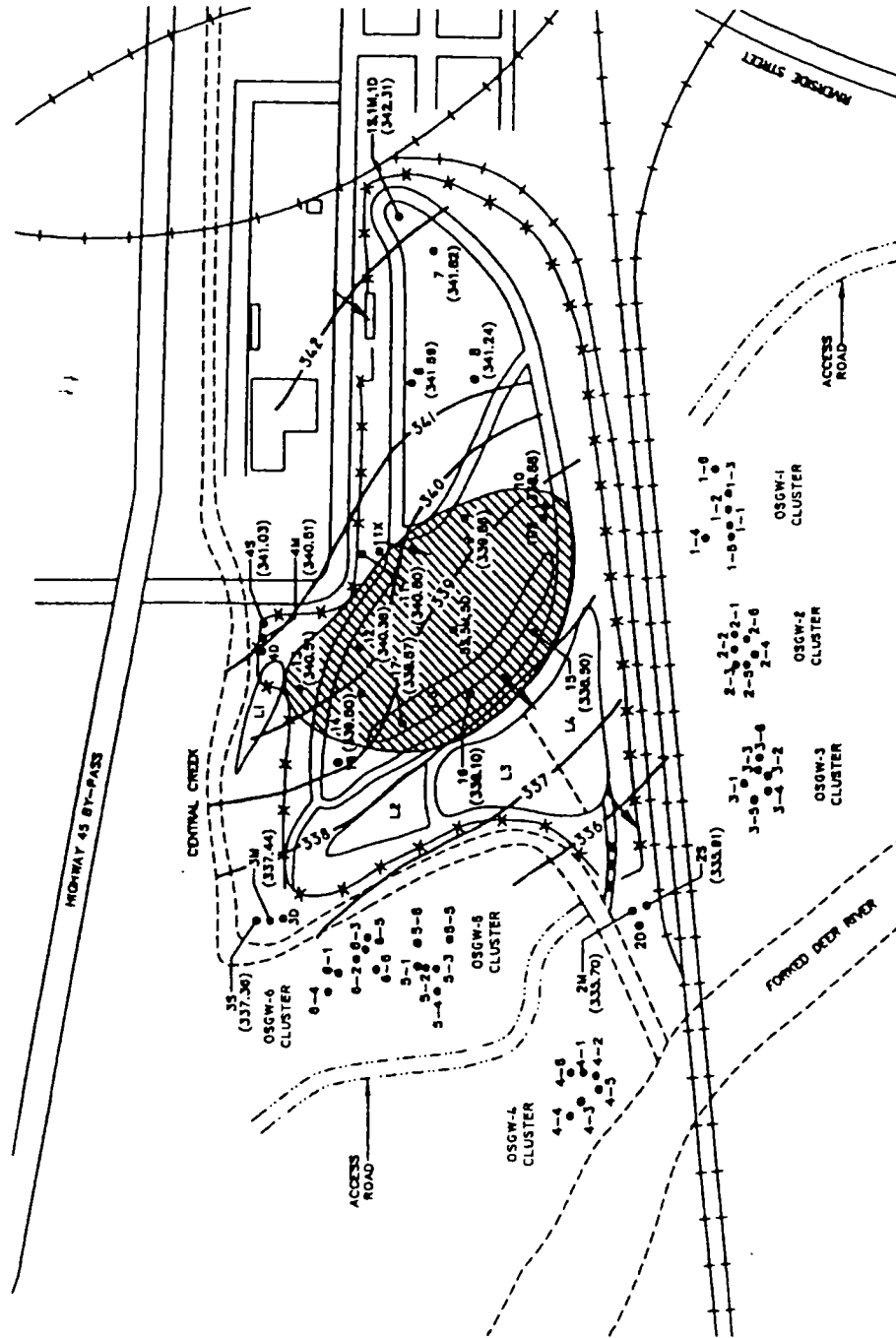
MARCH 2, 1987

CLIENT: AMERICAN CREOSOTE WORKS DS

LOCATION: JACKSON TENNESSEE

DESIGNED: SDJF PROJECT NO.: 834304

7



APPROXIMATE SCALE
350 700 FEET

LEGEND

- 20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- L3 LAGOON (INFERRED) BOUNDARIES
- (341.86) GROUNDWATER ELEVATION (FEET)
- 340 --- GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION

REFERENCE

SAME FINAL RI, 1988 (FIGS 4-3A, 4-4, 4-5)
 U.S.G.S. WRIIR #93-4170
 DNM (17) SOLIDIFICATION/STABILIZATION
 WORKPLAN, 1988 (INFERRED CAP LOCATION),
 TABLE 1



Shaw Environmental, Inc.

242 MORTIMER PARK DRIVE
 SUITE 102
 MEMPHIS, TN 37129
 (615) 847-1800

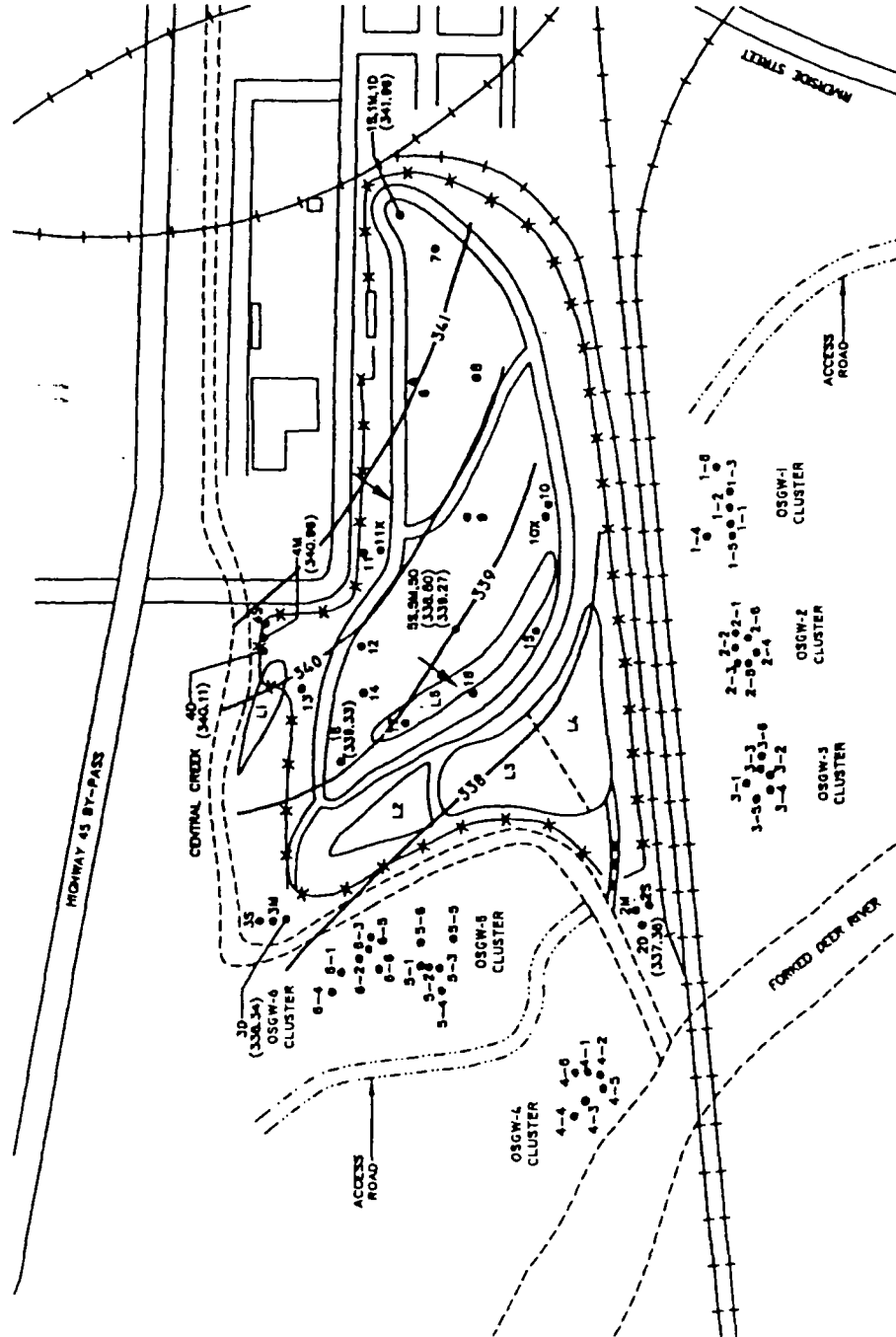
REV. NO.: DRAWING DATE: 3-23-04 ACAD FILE: 4304819

POTENTIOMETRIC SURFACE MAP
 FT. PILLOW AQUIFER
 MARCH 2, 1987

CLIENT: AMERICAN CREOSOTE WORKS
 TDSF No. 57-508

LOCATION: JACKSON TENNESSEE

DESIGNED: DS SOUP PROJECT NO.: 834304
 DRAWN: KR FIGURE: 8



APPROXIMATE SCALE
 150 700 FEET

LEGEND

- 20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- 12 ✕ DESTROYED MONITORING WELL CLUSTERS (INCLUDING 5S, 5M, 5O, POSSIBLY 1S, 1M, 1O)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- L3 LAGOON (INFERRED) BOUNDARIES (336 50)
- 336 GROUNDWATER ELEVATION (FEET)
- GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- FREE PHASE CREOSOTE (DETECTED AS DNAPL)
- NG NOT GAUGED

REFERENCE

SEAME FINAL RI, 1988 (FIGS 4-3A, 4-4, 4-5)
U.S.O.S. WRIR #93-4170
OHM (1) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1999 (INFERRED CAP LOCATION),
TABLE 1



Shaw Environmental, Inc.
242 HERITAGE PARK DRIVE
SUITE 100
MARTINSBURG, TN 37128
(810) 887-1800

REV. NO.: DRAWING DATE: 3-23-04 ACAD FILE: 4304870

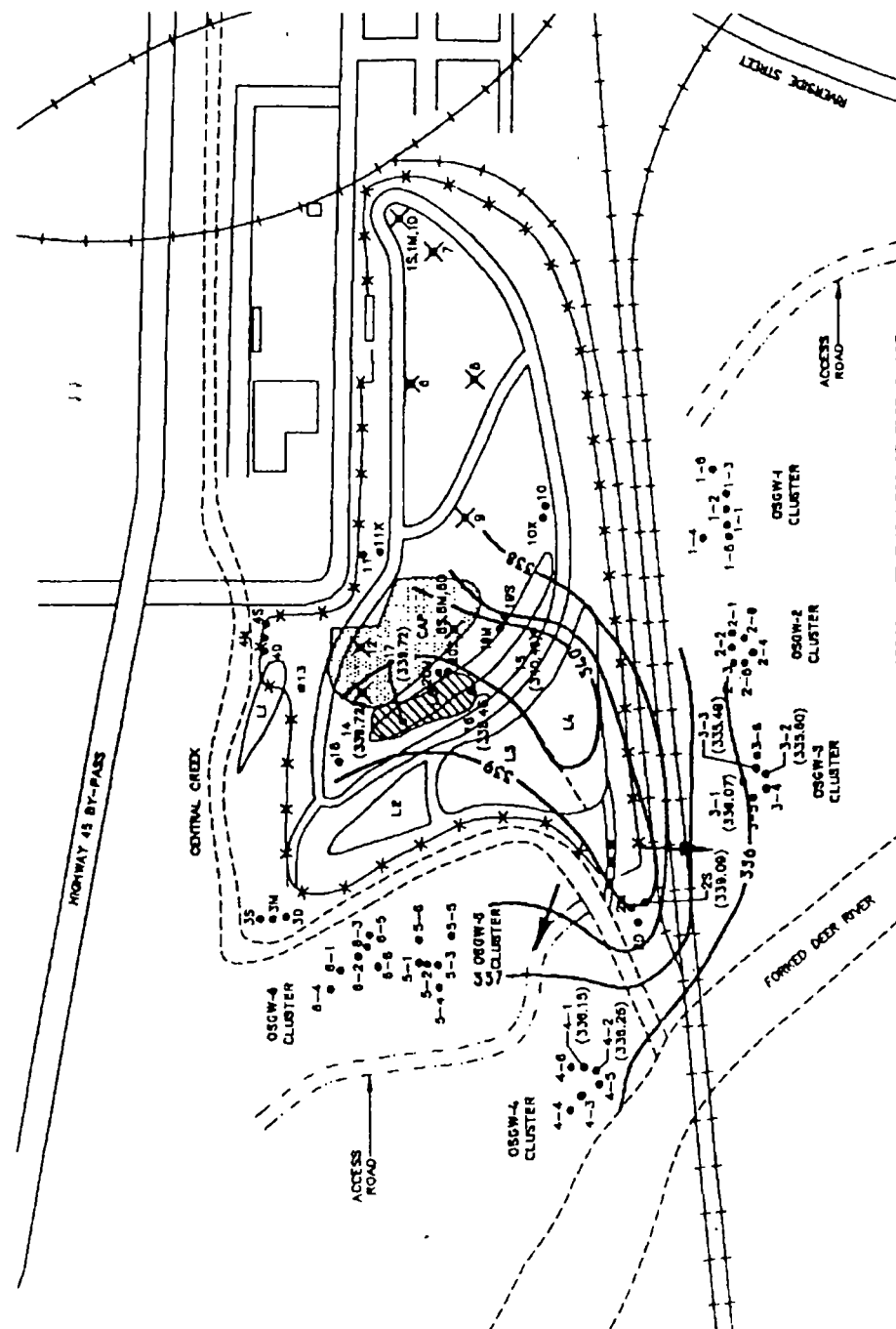
POTENTIOMETRIC SURFACE MAP (ALLUVIAL AQUIFER) MARCH 2003

CLIENT: AMERICAN CREOSOTE WORKS
TDSF No. 57-508

LOCATION: JACKSON TENNESSEE

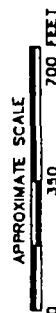
DESIGNED: DS
DETAILER: SDJF
PROJECT NO.: 834304

FIGURE: 9



APPROXIMATE THICKNESS OF FREE-PHASE
CREOSOTE (AS A DNAPL):

- MW-16: 10 FEET
- MW-17: 9 FEET
- MW-20S: 3.5 FEET



LEGEND

- 20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- 12 ✕ DESTROYED MONITORING WELL CLUSTERS (INCLUDING 5S, 5M, 5O, POSSIBLY 1S, 1M, 1O)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- L3 LAGOON (INFERRED) BOUNDARIES
- (339.39) GROUNDWATER ELEVATION (FEET)
- 339 --- GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION

REFERENCE:

STATE FINAL RI, 1988 (FIGS-3A, 4-4, 4-5)
U.S.G.S. WRIR #93-4170
OHM (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1999 (INFERRED CAP LOCATION).
TABLE 1



242 MORTGAGE PARK DRIVE
SUITE 102
MEMPHIS, TN 37129
(901) 847-1800

REV. NO.: DRAWING DATE: 3-23-04 ACAD FILE: 4304821

POTENTIOMETRIC SURFACE MAP
(FT. PILLOW AQUIFER)
MARCH 2003

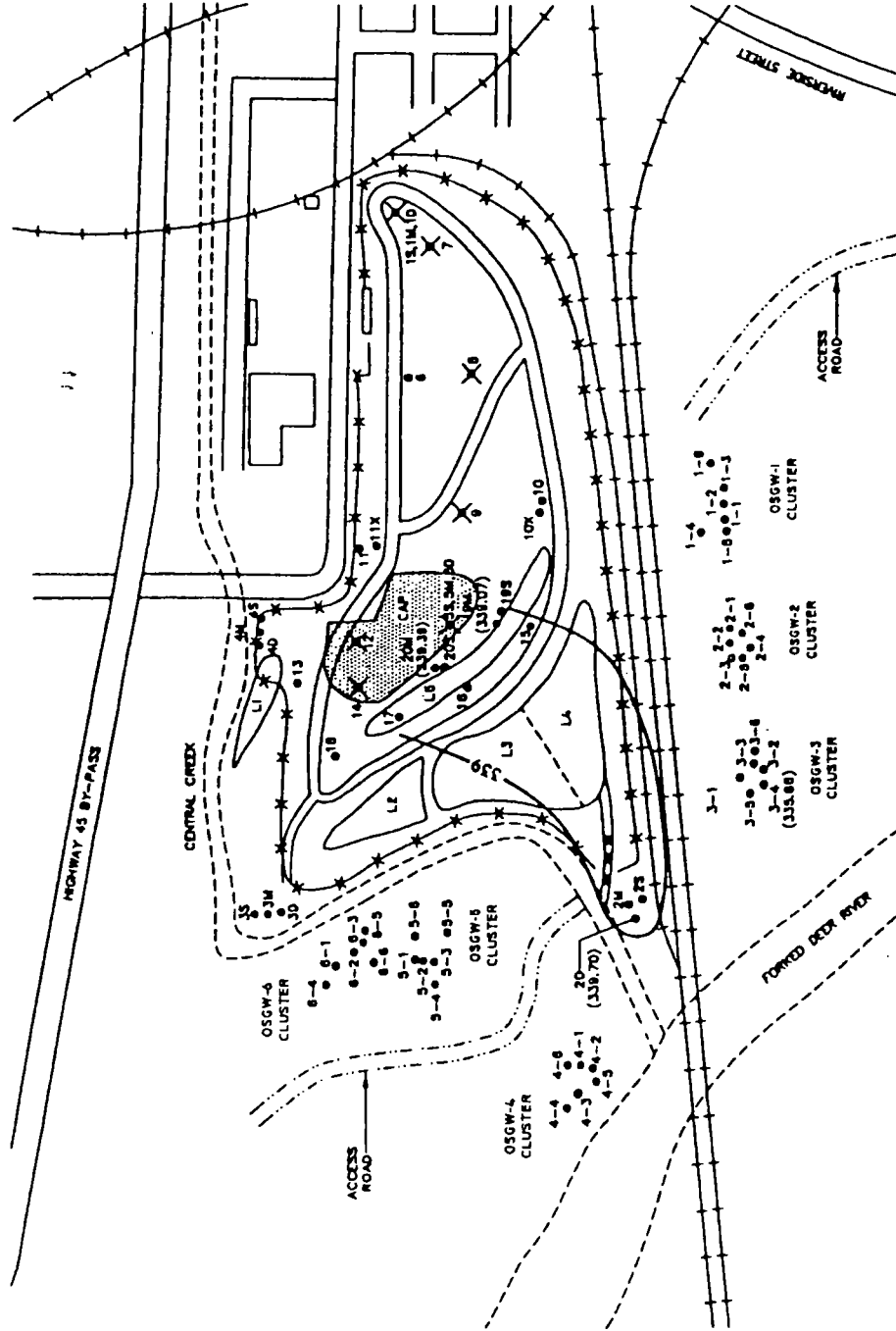
CLIENT: AMERICAN CREOSOTE WORKS
TDSF No. 57-508

LOCATION: JACKSON TENNESSEE

DESIGNED BY: PROJECT NO.: 834304

DS DS/UF DS

FIGURE: 10



APPROXIMATE SCALE
350 700 FEET

LEGEND

- 20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- L3 LAGOON (INFERRED) BOUNDARIES
- (339.39) GROUNDWATER CONCENTRATION, SUM OF VOC CONSTITUENTS (ppb)
- 100--- CONCENTRATION CONTOUR
- FREE PRODUCT CREOSOTE
- ND NON-DETECT (BELOW LABORATORY DETECTION LIMITS)

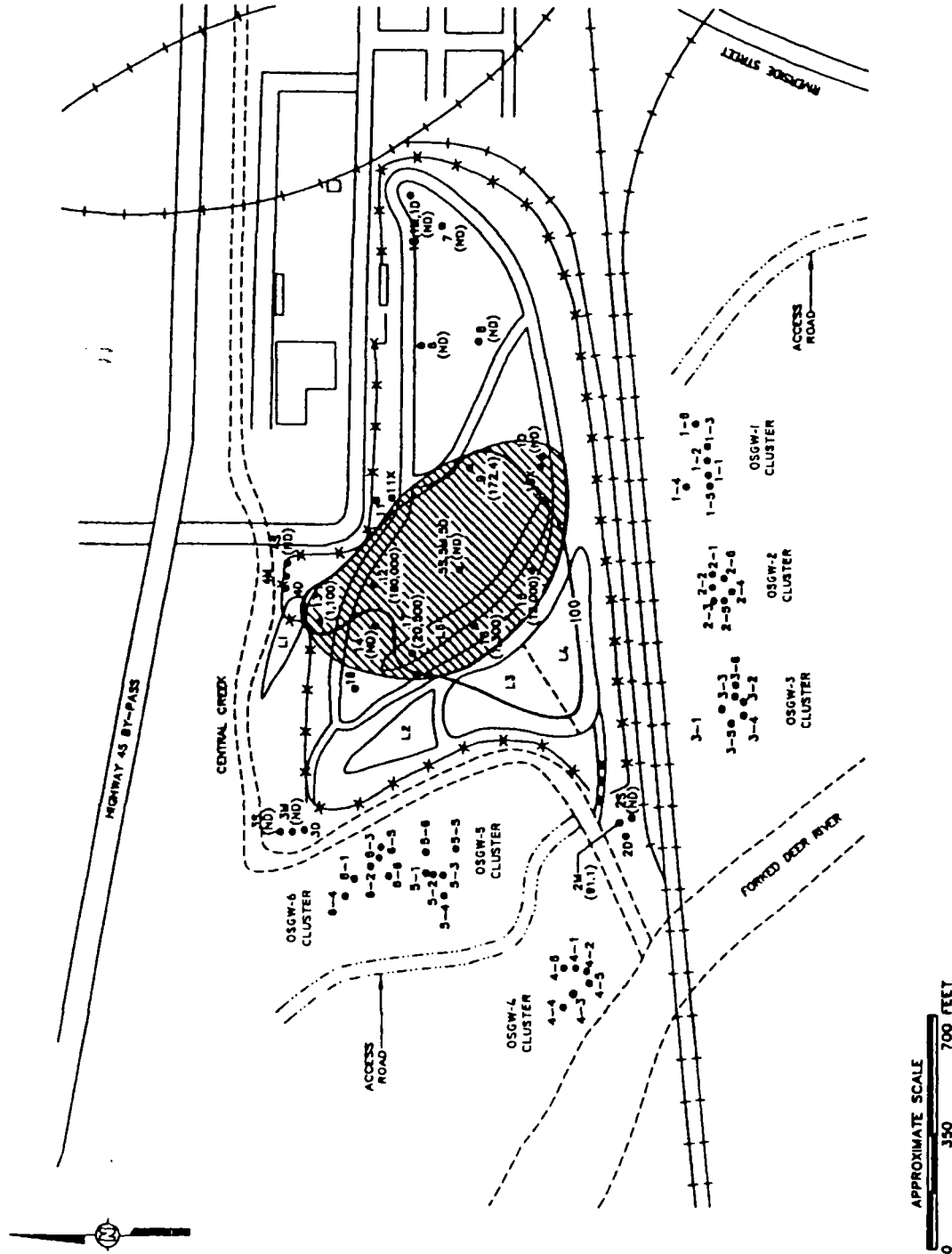
REFERENCE

STATE FINAL RI, 1986 (FIGS 4-3A, 4-4, 4-5)
U.S.G.S. WIRE #93-4170
OHM (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1999 (INFERRED CAP LOCATION),
TABLE 1



242 MORTGAGE PARK DRIVE
SUITE 102
MEMPHIS, TN 37129
(901) 867-1805
Shaw Environmental, Inc.

REV. NO.: 3-23-04	ACAD FILE: 4304822
GROUNDWATER CONCENTRATION MAP VOC CONSTITUENTS ALLUVIAL AQUIFER	
JANUARY 87 AND OCTOBER 88	
CLIENT: AMERICAN CREOSOTE WORKS TDS# No. 57-508	PN: DS
LOCATION: JACKSON, TENNESSEE	PL/NO: KR
DESIGNED: DS	DRAWN: DS
PROJECT NO.: 83-4304	FIGURE: 11



LEGEND

- 20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- L3 LAGOON (INFERRED) BOUNDARIES
- (100) GROUNDWATER CONCENTRATION, SUM OF VOC CONSTITUENTS (ppb)
- ND NON-DETECT (BELOW LABORATORY DETECTION LIMITS)

REFERENCE:

STATE FINAL M. 1988 (FIGS 4-3A, 4-4, 4-5)
U.S.G.S. WRIR #93-4170
OHM (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1989 (INFERRED CAP LOCATION),
TABLE 1



242 MORTGAGE PARK DRIVE
SUITE 102
NASHVILLE, TN 37129
(615) 847-1800
Shaw Environmental, Inc.

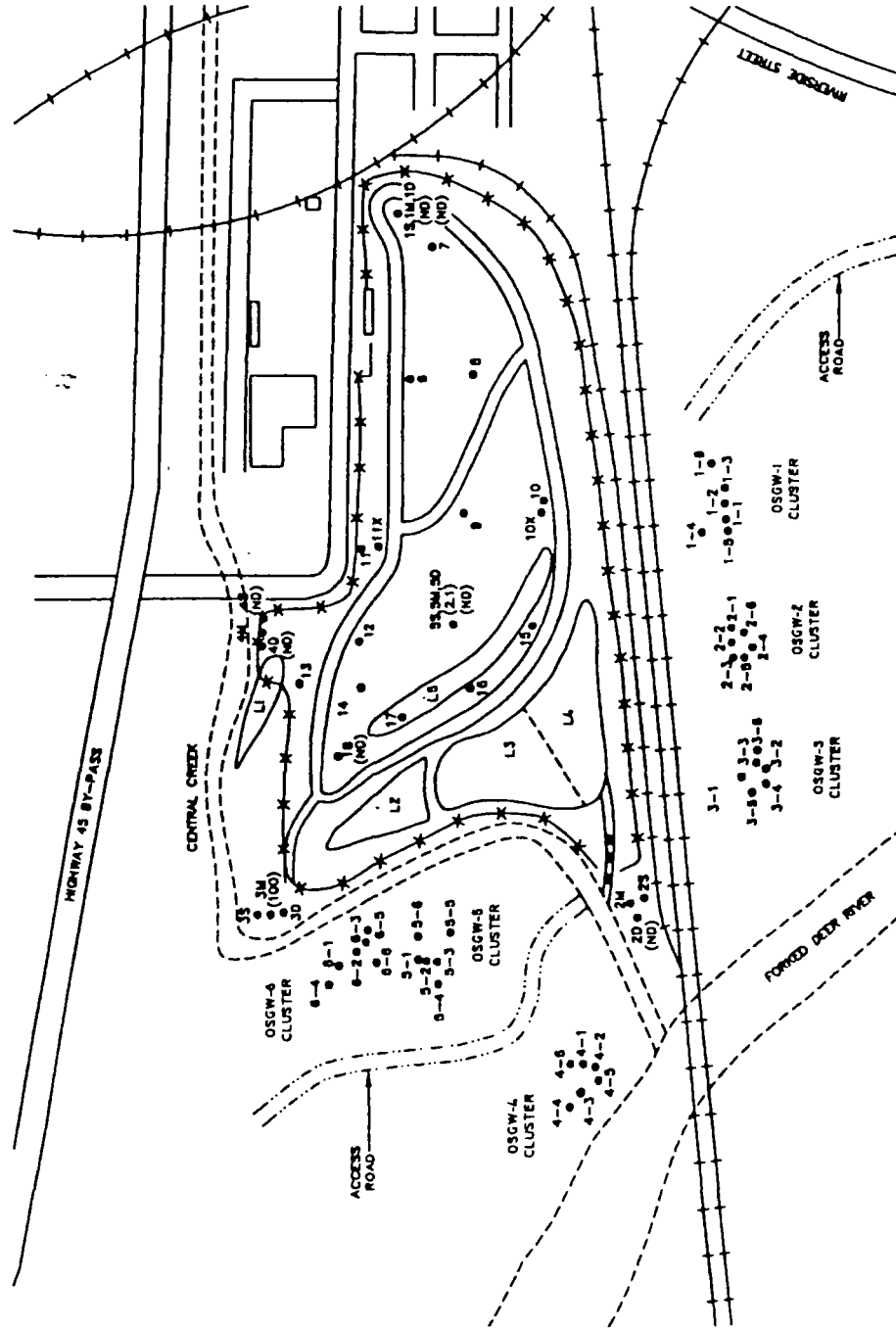
REV. NO.: DRAWING DATE: 3-23-04 ACAD FILE: 4304823

GROUNDWATER CONCENTRATION MAP VOC CONSTITUENTS FT. PILLOW AQUIFER JANUARY 87 AND OCTOBER 88

CLIENT: AMERICAN CREOSOTE WORKS
TDSF No. 97-508

LOCATION: JACKSON TENNESSEE

DESIGNED: DS SDUF PROJECT NO.: 834304
FIGURE: 12



APPROXIMATE SCALE
0 350 700 FEET

LEGEND

20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)

--- STREAM

--- RAILROAD

--- FENCE

--- DRAINAGE CULVERT

L3 LAGOON (INFERRED) BOUNDARIES

(2.6) GROUNDWATER CONCENTRATION, SUM OF PAH CONSTITUENTS (ppb)

ND NON-DETECT (BELOW LABORATORY DETECTION LIMITS)

REFERENCE:

SAME FINAL RI, 1988 (FICS4-3A, 4-4, 4-5)

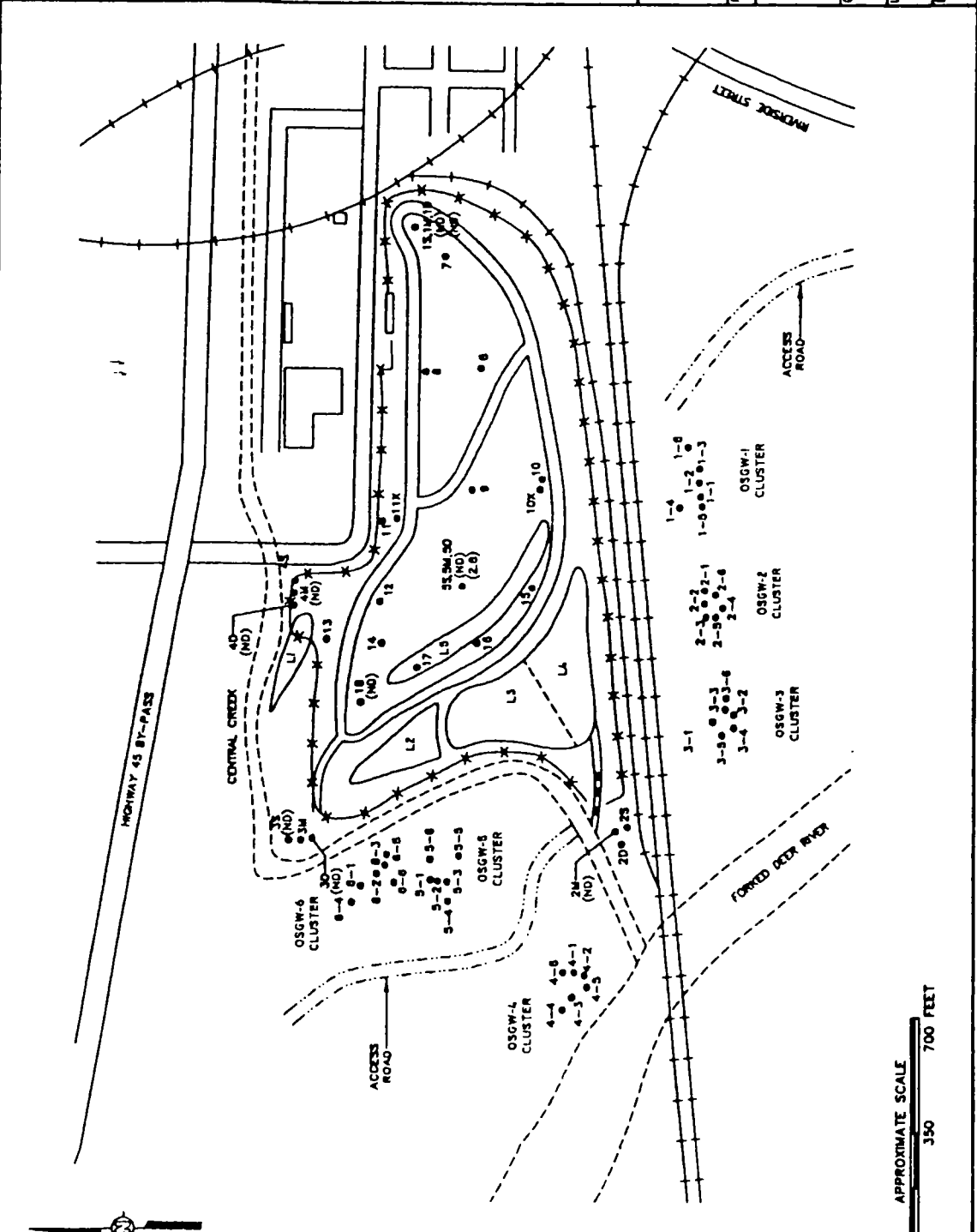
U.S.G.S. WHIR #03-4170

OHM (IT) SOLIDIFICATION/STABILIZATION WORKPLAN, 1998 (INFERRED CAP LOCATION), TABLE 1

Shaw Shaw Environmental, Inc.

242 MORTGAGE PARK DRIVE
SUITE 102
MURFREESBORO, TN 37129
(615) 847-1000

REV. NO.:	DRAWING DATE:	ACAD FILE:	4304825
GROUNDWATER CONCENTRATION MAP		PAH CONSTITUENTS	
FT. PILLOW AQUIFER		JANUARY 87 AND OCTOBER 88	
CLIENT:	AMERICAN CREOSOTE WORKS TDSF No. 57-508		PL: DS
LOCATION:	JACKSON TENNESSEE		PL/KG: KR
DESIGNED:	DATE/NO.:	PROJECT NO.:	FIGURE
DS	SDUF	834304	14



LEGEND

- 204 ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- L3 LAGOON (INFERRED) BOUNDARIES
- (194.5) GROUNDWATER CONCENTRATION, SUM OF PCP CONSTITUENTS (ppb)
- 100 CONCENTRATION CONTOUR
- FREE PRODUCT CREOSOTE
- ND NON-DETECT (BELOW LABORATORY DETECTION UNITS)

REFERENCE

SAME FINAL RI, 1988 (FIGS 4-JA, 4-4, 4-5)
U.S.G.S. WHIR #3-4170
OHM (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1998 (INFERRED CAP LOCATION),
TABLE 1



242 HORTON PARK DRIVE
SUITE 107
MEMPHIS, TN 37129
(913) 867-1800

REV. NO.: DRAWING DATE: 3-23-04 ACAD FILE: 4304826

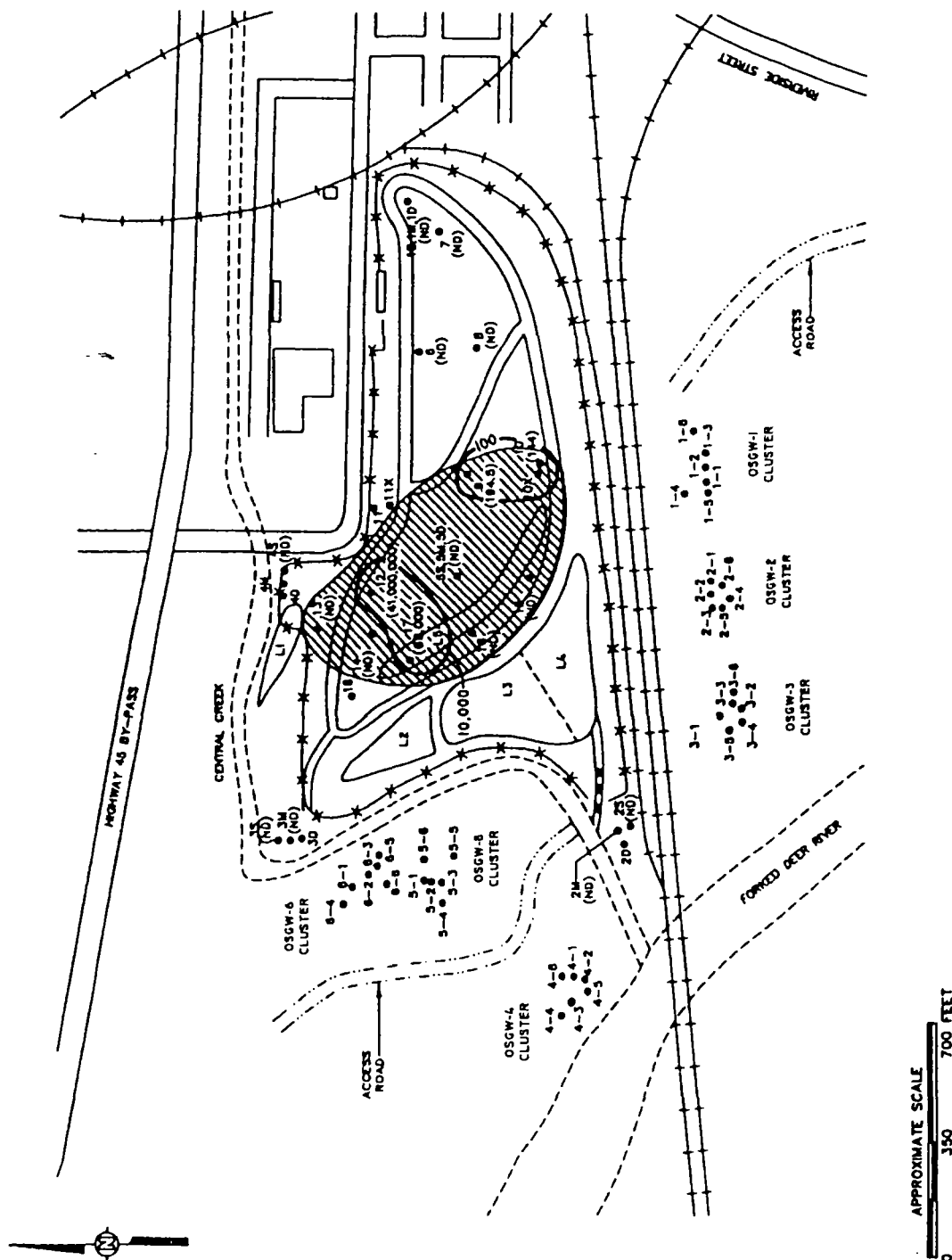
GROUNDWATER CONCENTRATION MAP
PCP CONSTITUENTS
ALLUVIAL AQUIFER
JANUARY 87 AND OCTOBER 88

CUSTOMER: AMERICAN CREOSOTE WORKS
TDS# No. 57-508

LOCATION: JACKSON TENNESSEE

DESIGNED: SDJF PROJECT NO.: 834304

FIGURE: 15



APPROXIMATE SCALE
0 350 700 FEET

LEGEND

- 20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- L3 LAGOON (INFERRED) BOUNDARIES
- (ND) GROUNDWATER CONCENTRATION, SUM OF PCP CONSTITUENTS (ppb)
- ND NON-DETECT (BELOW LABORATORY DETECTION LIMITS)

REFERENCE

SAME FINAL RI, 1988 (FOS4-3A, 4-4, 4-5)
U.S.G.S. WRRR #03-4170
OHM (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1988 (INFERRED CAP LOCATION).
TABLE 1



Shaw Environmental, Inc.
242 HERITAGE PARK DRIVE
SUITE 100
MARTINSDALE, TN 37129
(615) 687-1800

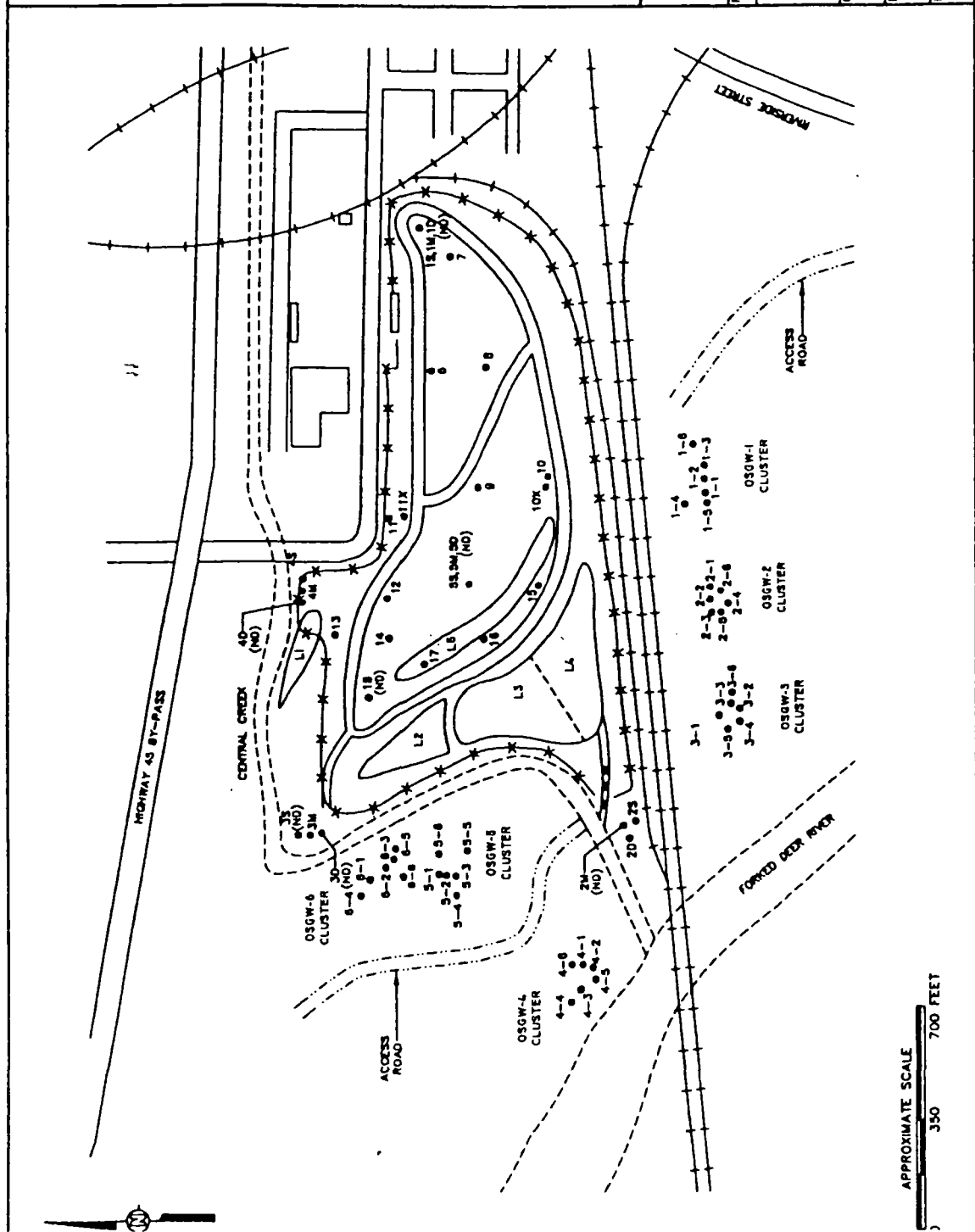
REV. NO.: 1-23-04 ROAD FILE: 4304B27

GROUNDWATER CONCENTRATION MAP
PCP CONSTITUENTS
FT. PILLOW AQUIFER
JANUARY 87 AND OCTOBER 88

CLIENT: AMERICAN CREOSOTE WORKS
TDS# No. 57-508

LOCATION: JACKSON TENNESSEE

DESIGNED: DS
CHECKED: SDJF
PROJECT NO.: 834304
FIGURE: 16



APPROXIMATE SCALE
350 700 FEET

LEGEND

- 20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- 12 ✕ DESTROYED MONITORING WELL CLUSTERS (INCLUDING 5S, 3M, 5D, POSSIBLY 1S, 1M, 1D)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- L3 LAGOON (INFERRED) BOUNDARIES
- (187) GROUNDWATER CONCENTRATION, SUM OF VOC CONSTITUENTS (ppb)
- ND NON-DETECT (BELOW LABORATORY DETECTION LIMITS)

REFERENCE:

SAME FINAL RI, 1988 (FICS4-3A, 4-4, 4-5)
U.S.G.S. WRIR #93-4170
CHM (IT) SOLIDIFICATION/STABILIZATION WORKPLAN, 1999 (INFERRED CAP LOCATION), TABLE 3



242 HERITAGE PARK DRIVE
SUITE 102
BARTLETSBORO, TN 37129
(615) 847-1605
Shaw Environmental, Inc.

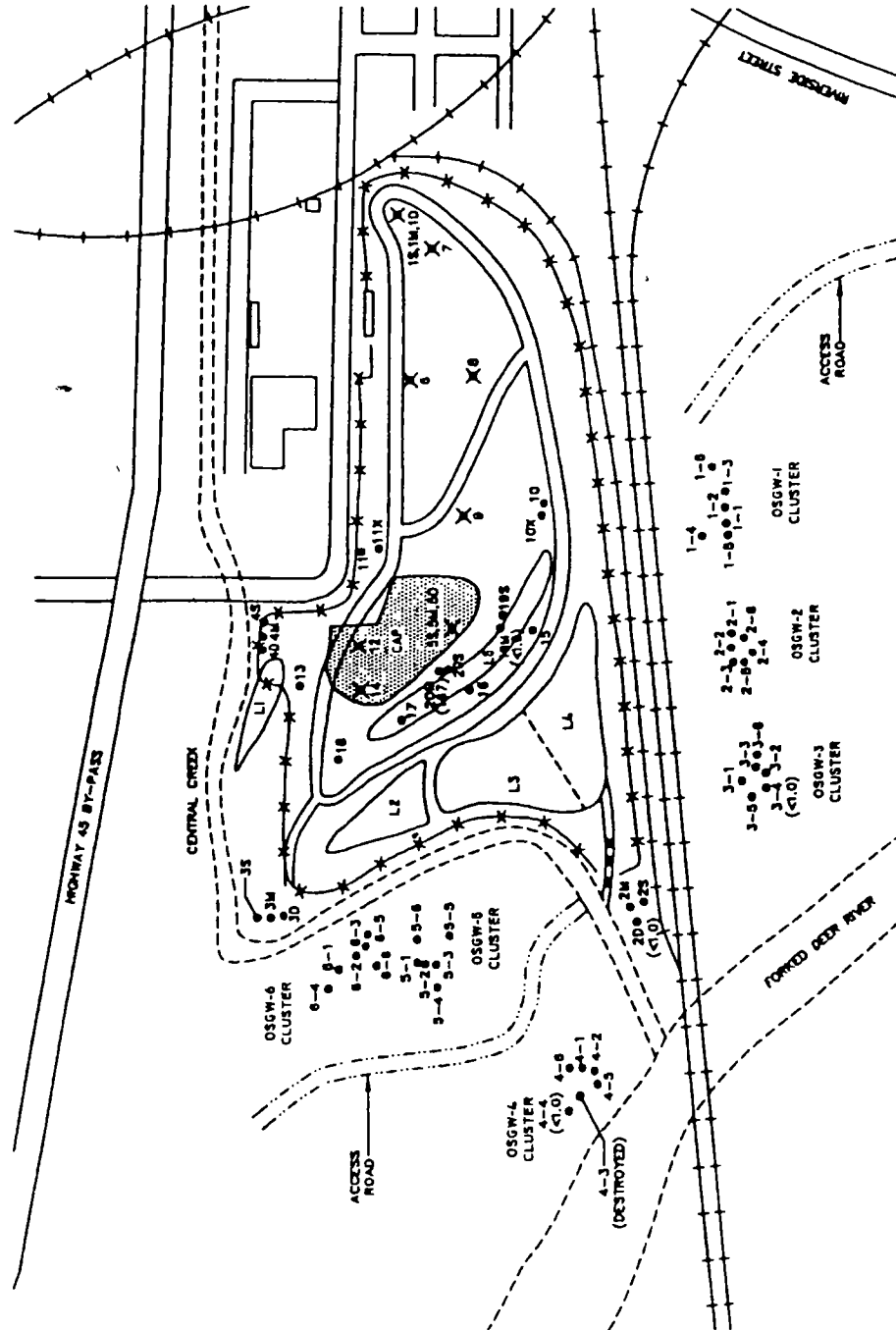
REV. NO.: DRAWING DATE: 3-22-04 ROAD FILE: 4304929

GROUNDWATER CONCENTRATION MAP
VOC CONSTITUENTS
FT. PILLLOW AQUIFER
MARCH 2003

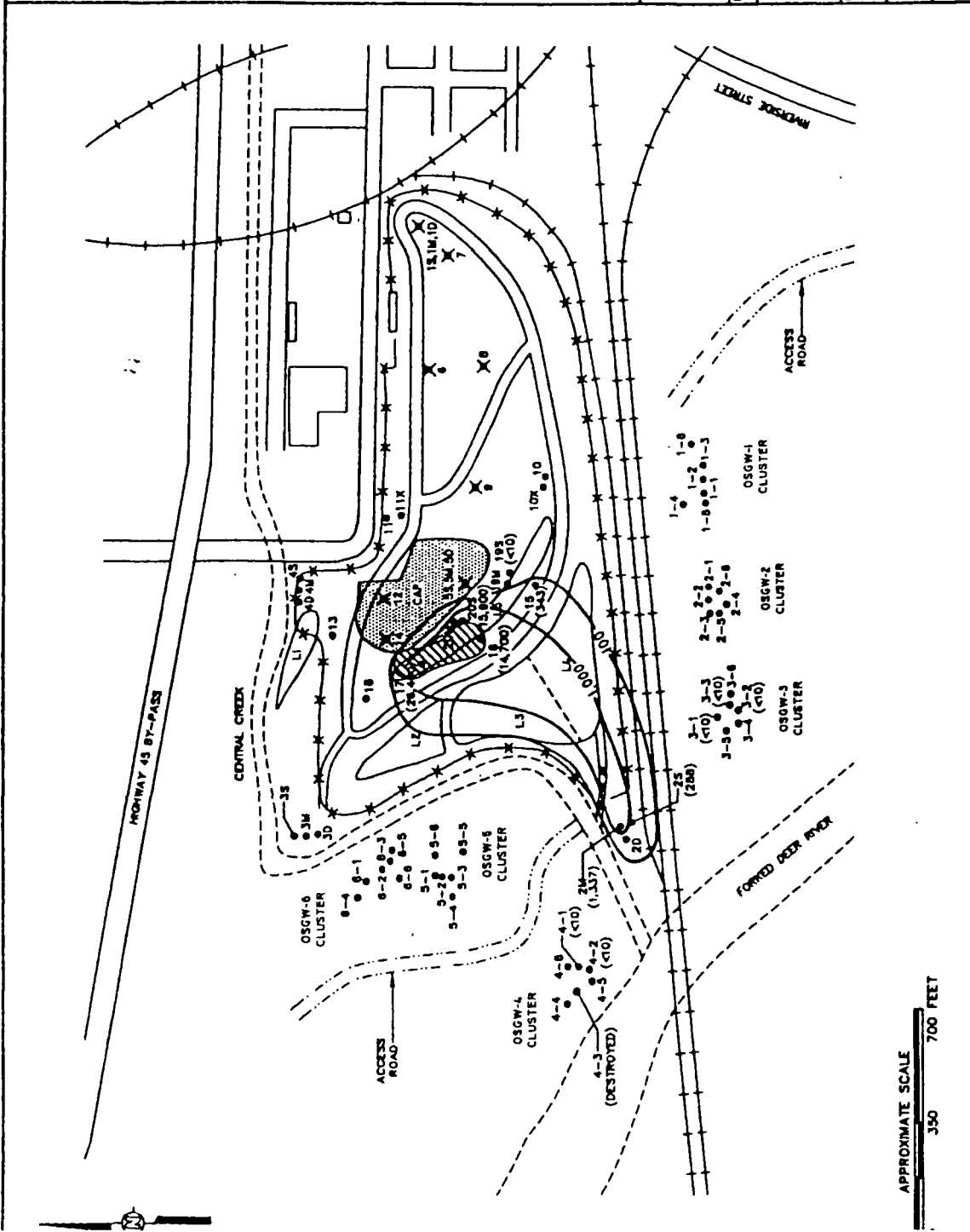
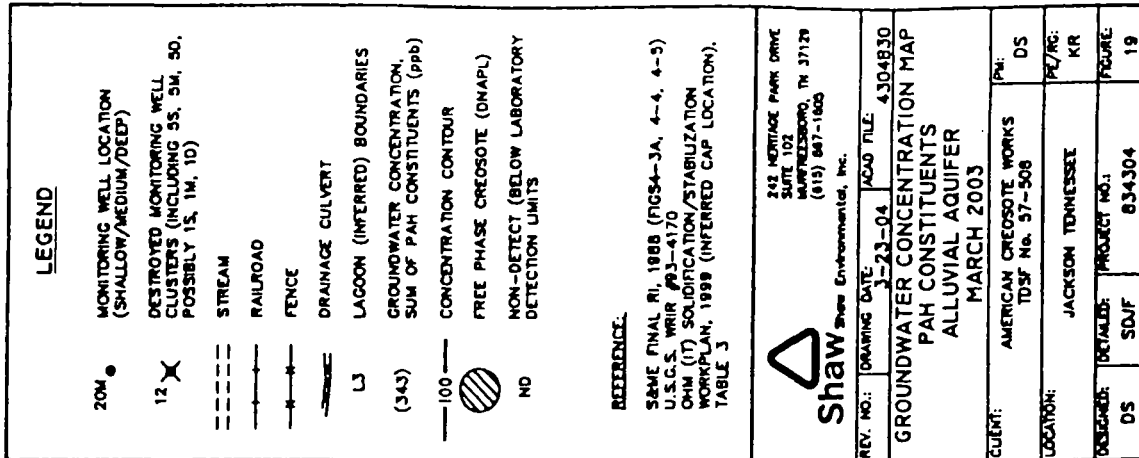
CUSTOMER: AMERICAN CREOSOTE WORKS
TDS# No. 57-508

LOCATION: JACKSON TENNESSEE

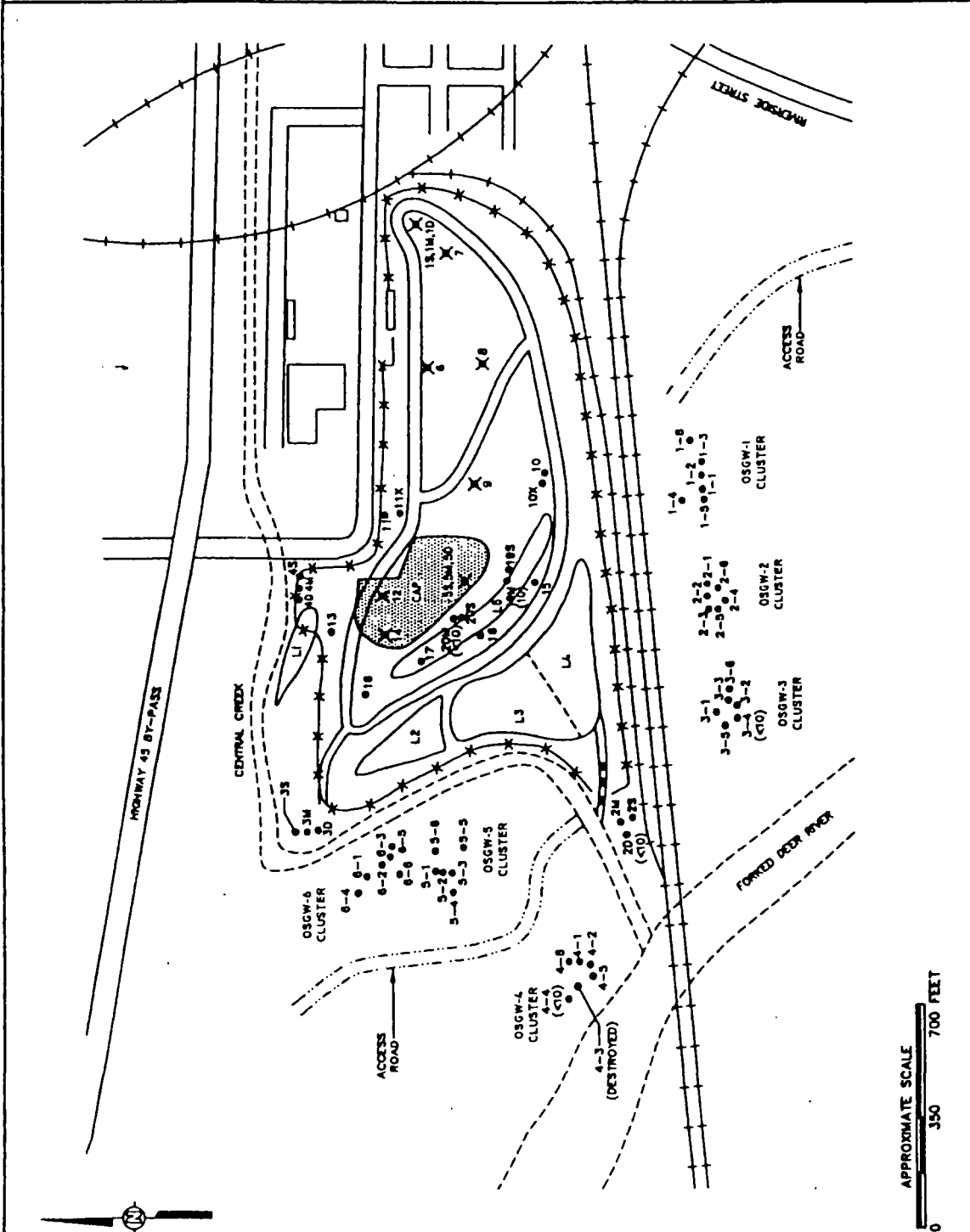
DESIGNED: DS
CHECKED: DSUF
PROJECT NO.: 834304
SHEET NO.: 18



APPROXIMATE SCALE
0 350 700 FEET



APPROXIMATE SCALE
 350 700 FEET



LEGEND

MONITORING WELL LOCATION
(SHALLOW/MEDIUM/DEEP)

DESTROYED MONITORING WELL
CLUSTERS (INCLUDING 5% 5M, 50,
POSSIBLY 1% 1M, 10)

STREAM

RAILROAD

FENCE

DRAINAGE CULVERT

LAGOON (INFERRED) BOUNDARIES

GROUNDWATER CONCENTRATION,
SUM OF PAH CONSTITUENTS (ppb)

NON-DETECT (BELOW LABORATORY
DETECTION LIMITS)

L3

(10)

ND

REFERENCE

SAME FINAL RI, 1988 (FIGS 4-3A, 4-4, 4-5)
U.S.G.S. WRIR #93-4170
OHM (17) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1998 (INFERRED CAP LOCATION),
TABLE 3

242 HERITAGE PARK DRIVE
SUITE 102
MARTINSDALE, TN 37129
(615) 867-1008

Shaw Environmental, Inc.

REV. NO.:	DRAWING DATE:	ACAD FILE:	4304831
GROUNDWATER CONCENTRATION MAP PAH CONSTITUENTS FT. PILLOW AQUIFER MARCH 2003			
CLIENT:	AMERICAN CREOSOTE WORKS TDSF No. 57-508	PU:	DS
LOCATION:	JACKSON TENNESSEE	PL/NG:	KR
DESIGNER:	DETAILS:	PROJECT NO.:	83A304
DS	SD/JF		20

LEGEND

- 20M ● MONITORING WELL LOCATION (SHALLOW/MEDIUM/DEEP)
- 12 ✕ DESTROYED MONITORING WELL CLUSTERS (INCLUDING 5S, 5M, 5O, POSSIBLY 1S, 1M, 1O)
- STREAM
- RAILROAD
- FENCE
- DRAINAGE CULVERT
- L3 LAGOON (INFERRED) BOUNDARIES
- (100) GROUNDWATER CONCENTRATION, SUM OF PCP CONSTITUENTS (ppb)
- 100--- CONCENTRATION CONTOUR
- FREE PHASE CREOSOTE (ONAPL)
- NON-DETECT (BELOW LABORATORY DETECTION LIMITS)

REFERENCE:

SEWAGE FINAL PL. 1988 (FIGS 4-3A, 4-4, 4-5)
U.S.G.S. WHP #93-4170
OHM (IT) SOLIDIFICATION/STABILIZATION
WORKPLAN, 1989 (INFERRED CAP LOCATION),
TABLE 3



242 MORTIMER PARK DRIVE
SUITE 102
BARTLETSBURG, TN 37129
(615) 847-1800

REV. NO.: DRAWING DATE: 3-23-04 ADO FILE: 4304B32

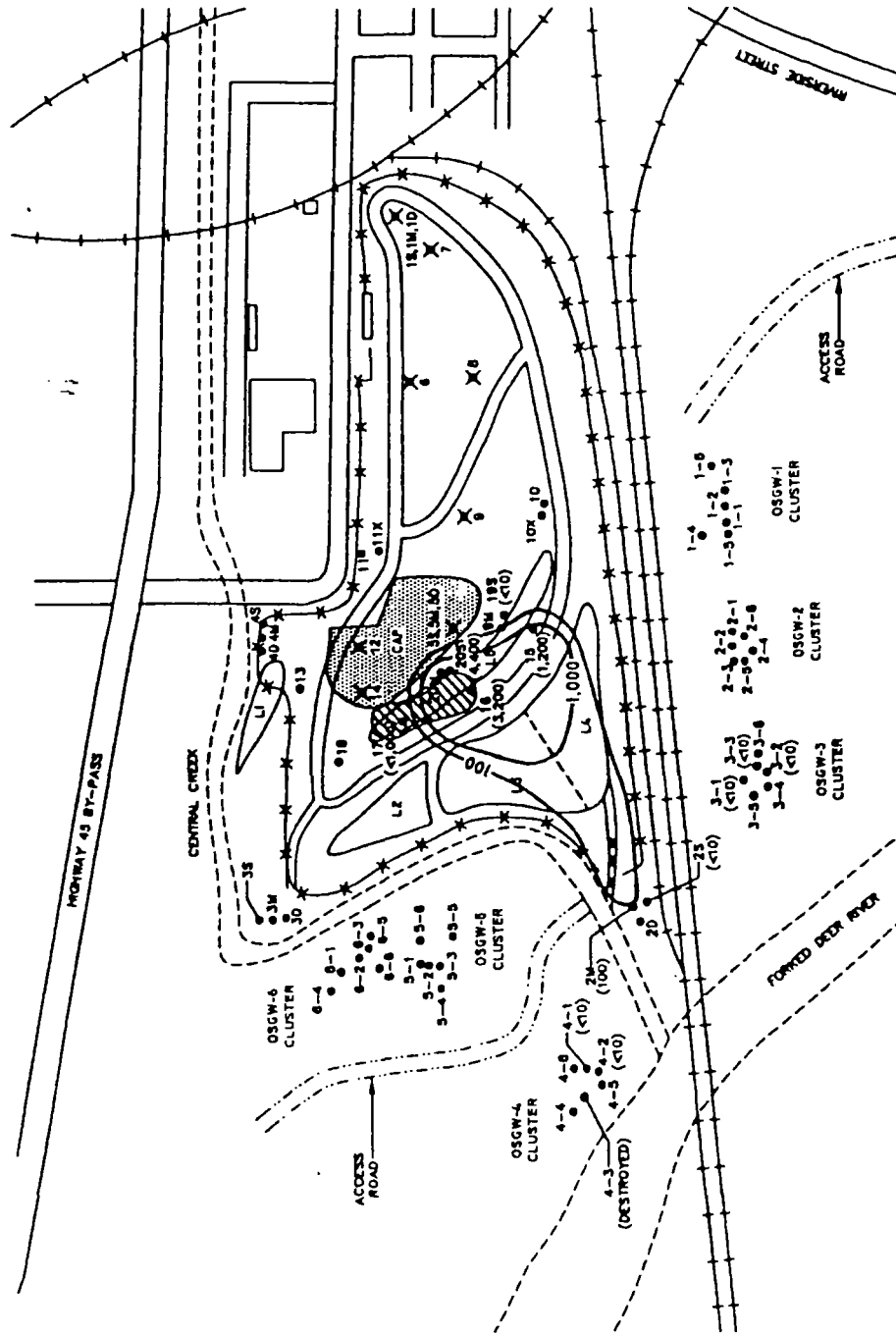
GROUNDWATER CONCENTRATION MAP PCP CONSTITUENTS ALLUVIAL AQUIFER MARCH 2003

CLIENT: AMERICAN CREOSOTE WORKS
TDSF No. 57-508

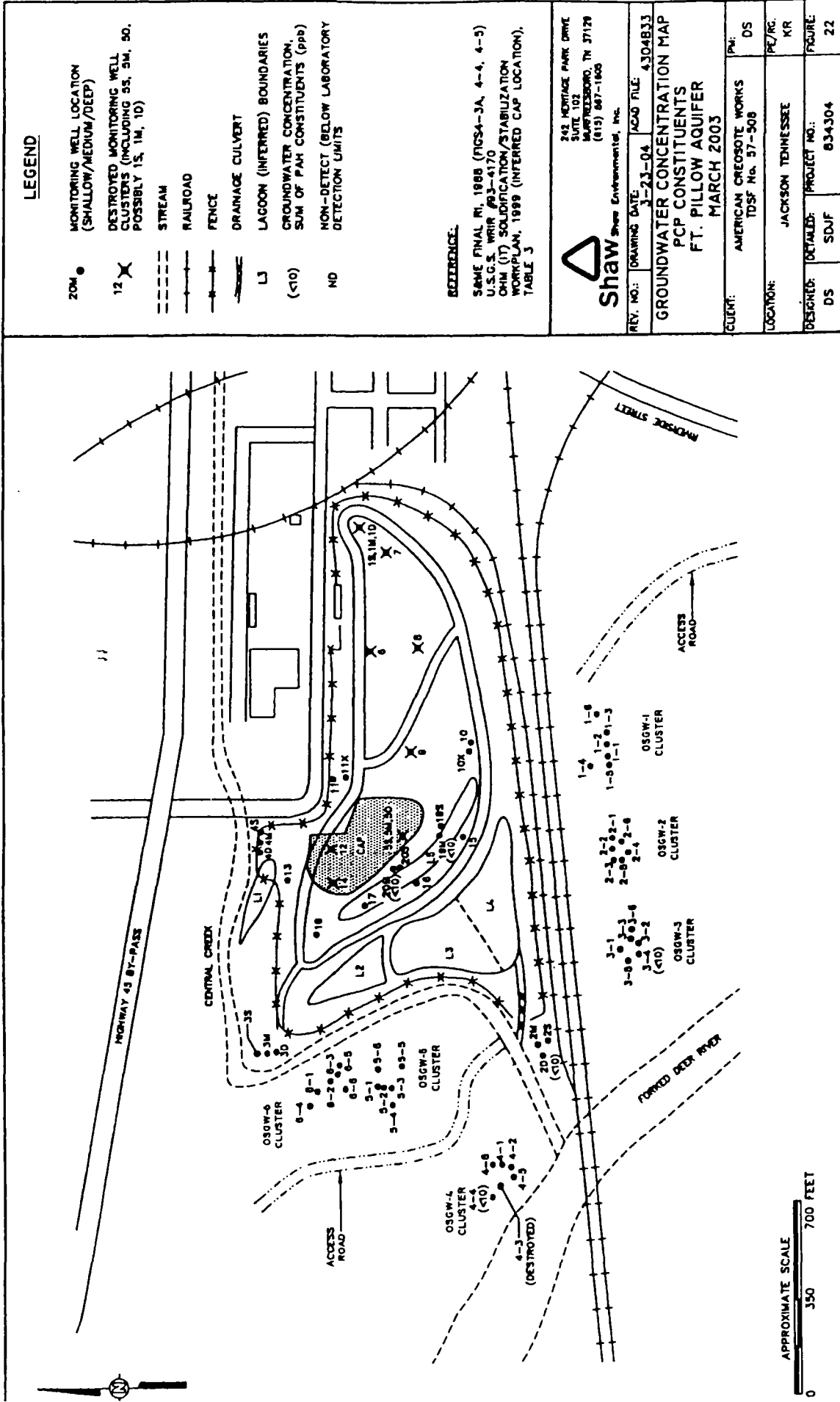
LOCATION: JACKSON TENNESSEE

DESIGNED: DS
CHECKED: DSUF
PROJECT NO.: 834304

21



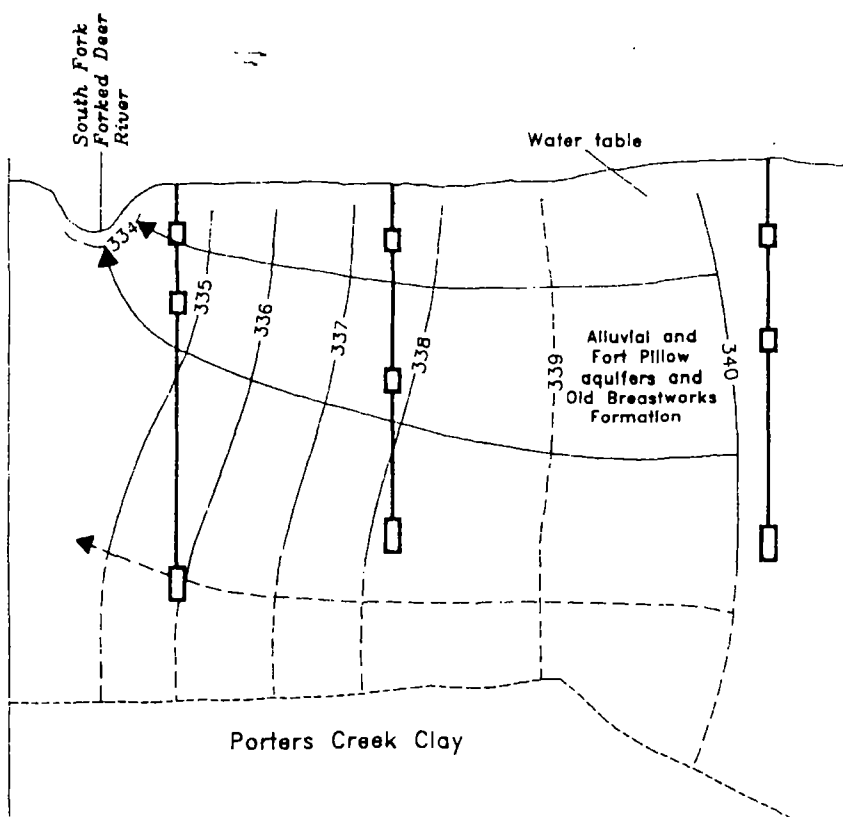
APPROXIMATE SCALE
0 350 700 FEET



APPENDIX E

**USGS GROUNDWATER STUDY REPORT
AMERICAN CREOSOTE WORKS SITE
JACKSON, TENNESSEE**

Hydrogeology, Ground-Water Quality, and Potential for Water-Supply Contamination near an Abandoned Wood-Preserving Plant Site at Jackson, Tennessee



United States Geological Survey Water-Resources Investigations Report 93-4170

Prepared in cooperation with the
U.S. Environmental Protection Agency,
Region IV, Waste Management Division,
North Superfund Remedial Branch



Hydrogeology, Ground-Water Quality, and Potential for Water-Supply Contamination near an Abandoned Wood-Preserving Plant Site at Jackson, Tennessee

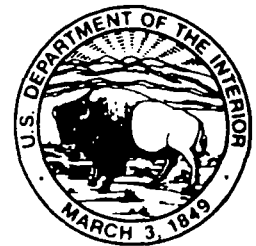
by WILLIAM S. PARKS, JUNE E. MIRECKI,
and JAMES A. KINGSBURY

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 93-4170

Prepared in cooperation with the
U.S. Environmental Protection Agency,
Region IV, Waste Management Division,
North Superfund Remedial Branch

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
ROBERT M. HIRSCH, Acting Director



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For additional information write to:

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U.S. Geological Survey
810 Broadway, Suite 500
Nashville, Tennessee 37203

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Denver Federal Center
Denver, Colorado 80225

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VERSION FACTORS, VERTICAL DATUM, WELL NUMBERING SYSTEMS, AND ACRONYMS

Multiply	By	To obtain
inch (in.)	2.54	centimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
acre	0.4047	square hectometer
foot per day (ft/day)	30.48	centimeter per day
gallons per minute (gal/min)	0.06309	liters per second

rel: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a 1 adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

and well numbering system: For consistency between reports, the onsite ground-water data collection stations and well rs in this report are the same as those used for the Remedial Investigation/Feasibility Study (S&ME, Inc., 1988). Onsite were numbered 1 through 18, with a few offset wells drilled later at some stations assigned the number of the first well with er "X" added as a suffix, for example 10X.

Wells in clusters of three at stations 1, 2, 3, 4, and 5 were assigned a station number followed by a letter indicating the general depth of the well. At station 1, for example, 1S was the designation for the shallow well; 1M for the intermediate depth well; and 1D for the deep well. In addition, several wells installed for the Tennessee Department of Health and Environment (*Tennessee Department of Environment and Conservation as of 1991*) before the Remedial Investigation/Feasibility Study was conducted were numbered AMW-1 through AMW-4.

During this investigation, wells installed in clusters of six at each of the six offsite stations (OSGW1 through OSGW6) were designated by adding hyphens (-) and well-numbers 1 through 6 to the station number for each of the six wells at each station (for example, OSGW1-1). In this report, USGS local well numbers for Tennessee are used to label stratigraphic test holes (fig. 3) and water-level observation wells (figs. 5 and 6) to aid in locating the geophysical logs and water-level data used. USGS local well numbers also are included in tables 2, 3, 5, 9, 10, 11, 12, 13, 14, 15, and 16 for cross reference.

In table 13 of this report, the 50 water-supply wells inventoried within a 2-mile radius of the American Creosote Works abandoned plant site were given map numbers (W1, W2, and so forth) for concise designation of wells on figure 14.

Tennessee District well-numbering system: Wells in Tennessee are identified according to the numbering system that is used by the U.S. Geological Survey, Water Resources Division. The well number consists of three parts:

- (1) an abbreviation of the name of the county in which the well is located;
- (2) a letter designating the 7 1/2-minute topographic quadrangle on which the well is plotted; quadrangles are lettered from left to right across the county beginning in the southwest corner of the county; and
- (3) a number generally indicating the numerical order in which the well was inventoried.

For example, Md:G-326 indicates that the well is located in Madison County on the "G" quadrangle and is identified as well 326 in the numerical sequence.

ACRONYMS

ACW = American Creosote Works, Inc.
BTEX = benzene, toluene, ethylbenzene, xylenes
DPT = Direct Push Technology
GC/PID = gas chromatography with photo-ionization detection
HPLC = high-performance liquid chromatography
JUD = Jackson Utility Division
MCL = maximum contaminant level
NAPL = non-aqueous phase liquids
NWQL = National Water Quality Laboratory
PAH = polynuclear aromatic hydrocarbon
PCP = pentachlorophenol
PVC = polyvinyl chloride
QA/QC = quality assurance/quality control
RI/FS = Remedial Investigation/Feasibility Study
SVC = semi-volatile compounds
TDEC = Tennessee Department of Environment and Conservation
USEPA = U.S. Environmental Protection Agency
USGS = U.S. Geological Survey
VOC = volatile organic compounds

Hydrogeology, Ground-Water Quality, and Potential for Water-Supply Contamination near an Abandoned Wood-Preserving Plant Site at Jackson, Tennessee

By William S. Parks, June E. Mirecki, and James A. Kingsbury

Abstract

An investigation was conducted by the U.S. Geological Survey from 1990 to 1993 to collect and interpret hydrogeologic and ground-water-quality data specific to the American Creosote Works (ACW) abandoned plant site at Jackson, Tennessee. The purposes of this investigation were to determine the extent and magnitude of ground-water contamination in offsite areas and to assess the potential for contamination of water-supply wells.

Direct Push Technology was used to collect water samples from the alluvial aquifer at six offsite stations near the ACW site at depths of less than 40 feet below land surface. In addition, 36 wells were installed in clusters of 6 wells at the 6 offsite stations to collect water samples from the alluvial aquifer at depths of less than about 40 feet and from the Fort Pillow aquifer at depths of as much as about 150 feet below land surface.

Ground-water samples collected with Direct Push Technology methods were analyzed for polynuclear aromatic hydrocarbons, phenolic compounds (including pentachlorophenol), and nitrogen-containing heterocyclic compounds using high-performance liquid chromatography. These samples also were analyzed for a selected list of volatile organic compounds using gas chromatography with photo-ionization detection. Water samples pumped from the 36 wells were analyzed for selected volatile and semi-volatile

organic compounds and for trace elements and major inorganic constituents.

Most contaminants in offsite areas were in samples from some wells screened in the alluvial aquifer. Naphthalene and volatile organic compounds were detected at concentrations that ranged generally from 0.2 to 20 micrograms per liter. Concentrations of all organic compounds were below State primary maximum contaminant levels for drinking water. Most contaminants are suspected to have been sorbed onto clay-mineral surfaces, or to have been degraded by microbial activity in the alluvial aquifer beneath the ACW site, before reaching the offsite areas.

Low concentrations of a few volatile organic compounds also were detected in samples from some offsite wells screened in the deeper Fort Pillow aquifer. Benzene and xylene were detected at concentrations ranging from 0.2 to 0.9 micrograms per liter, at depths of as much as 135 feet below land surface. However, semi-volatile organic compounds that commonly characterize contamination from wood-preserving processes were not detected in the Fort Pillow aquifer.

Two wells in the Jackson Utility Division South Well Field and an industrial well screened in the Fort Pillow aquifer east (upgradient) of the ACW site were sampled. The samples were analyzed for the same organic compounds and inorganic constituents as the 36 offsite wells near the ACW site.

Tetrachloroethylene, trichloroethylene, chloroform, and other volatile organic compounds were detected at low concentrations in water from these three wells. The detection of these contaminants, which are not commonly associated with woodpreserving processes, in the well-field wells is problematic inasmuch as many possible sources for these contaminants exist in the well-field area.

In addition to sampling the three wells in the Fort Pillow aquifer east of the ACW site, a domestic well, an industrial well, and an agricultural well screened in this aquifer west (downgradient) of the site were sampled. No contaminants from the ACW site were detected in the samples from these wells.

INTRODUCTION

American Creosote Works, Inc. (ACW) operated a wood-preserving plant at Jackson, Tennessee, for about 50 years (1930's until December 1981). Both creosote and pentachlorophenol (PCP) were used in the wood-preserving processes. Operations at this facility caused significant soil, surface-water, and ground-water contamination, and in 1984, the abandoned plant site was placed on the U.S. Environmental Protection Agency (USEPA) Superfund National Priorities List. Although a Remedial Investigation/Feasibility Study (RI/FS) was conducted at the ACW site for the USEPA (S&ME, Inc., 1988), available data were inadequate to assess the associated effects on nearby surface water or to delineate and characterize any offsite ground-water contamination. Subsequently, the U.S. Geological Survey (USGS) in cooperation with the North Superfund Remedial Branch, Waste Management Division, of the USEPA, Region IV, conducted investigations from 1990 to 1993 to determine and document toxicological effects on nearby surface waters, to delineate and characterize any ground-water contamination in offsite areas, and to assess the potential for contamination of water-supply wells.

Purpose and Scope

This report summarizes the results of the USGS investigation of ground-water contamination in areas near the ACW site and presents the hydrogeologic, water-level, and water-quality data

collected. The report also summarizes the field work conducted and procedures followed during the investigation (Appendix 1) and presents geologic information from stratigraphic test holes and construction details for wells installed (Appendix 2).

The specific objectives of the ground-water investigation were to determine the areal extent and magnitude of contaminants in ground water in areas near the ACW site and to assess the potential for water-supply contamination from the site with emphasis on the municipal wells in the Jackson Utility Division (JUD) South Well Field. The offsite ground-water investigation was limited to areas within about 500 feet to the south and west of the ACW site. The assessment of the potential for water-supply contamination was limited to an area within a 2-mile radius of the site.

Approach

Because areas where the offsite ground-water investigation was to be conducted were located in low-lying, swampy terrain, and because depths of possible contaminant migration determined during the work conducted for the onsite RI/FS (S&ME, Inc., 1988) exceeded the capabilities of most small, lightweight drilling rigs, much consideration was given to the selection of subsurface exploration and ground-water sampling methods before the offsite investigation was begun. Direct Push Technology (DPT) of In-Situ Technology, Orlando, Florida, and a modified-auger method of subsurface exploration and ground-water sampling were evaluated at two onsite ground-water data-collection stations at the ACW site to determine the suitability of these methods for use during the offsite investigation (Parks and others, 1993). In addition, gas chromatography with photo-ionization detection (GC/PID), high-performance liquid chromatography (HPLC), CHEMetrix phenol analysis, and Microtox bioassay methods for water-quality analysis also were evaluated.

Results from this evaluation showed that DPT methods were useful for lithologic data and ground-water-sample collection to depths less than about 35 feet below land surface, which was the approximate depth limit of penetration refusal of the DPT piezocone and Hydrocone tools. Ground-water samples collected with the modified-auger method

ed to be susceptible to downhole contamination contaminated zones were penetrated. Of the water-quality-analysis methods evaluated, the PID and HPLC proved to be the most effective detecting contaminants in ground water (Parks others, 1993).

On the basis of the onsite evaluation of meth-DPT was used for collecting lithologic data ground-water samples to depths of about 10 feet below land surface (depth of penetration) at six offsite stations and GC/PID and HPLC were used for analysis of the ground-water samples collected. In addition, six wells were drilled at each of the six offsite stations. Three at each station were screened at depths less than about 10 feet below land surface (depths determined from DPT work and GC/PID and HPLC analyses), three wells were screened from about 40 to 60 feet below land surface (depths determined from stratigraphic test holes drilled at each station). Major work tasks performed for the offsite ground-water investigation and the assessment of potential for water-supply contamination were:

- (1) inventorying water-supply wells within a 2-mile radius of the ACW site;
- (2) recording water levels continuously in 1 shallow well and 1 deep well onsite;
- (3) drilling stratigraphic test holes at 3 onsite and 6 offsite stations;
- (4) conducting DPT work to collect lithologic data and ground-water samples at the 6 offsite stations;
- (5) analyzing these ground-water samples using field GC/PID and laboratory HPLC methods;
- (6) installing and developing 36 wells for ground-water sample collection at the 6 offsite stations;
- (7) measuring water levels in 33 onsite and 36 offsite wells, during seasonal high and low water levels;
- (8) sampling the 36 wells installed at the 6 offsite stations;
- (9) sampling 6 water-supply wells screened in the Fort Pillow aquifer and 1 screened in the alluvial aquifer within a 2-mile radius of the site;
- (10) analyzing the water samples collected from the 36 offsite wells and 7 water-supply wells;

- (11) compiling and interpreting hydrogeologic, water-level, and water-quality data; and
- (12) preparing this report for publication.

SITE DESCRIPTION

The ACW abandoned plant site (fig. 1) is located in the southwestern part of the city of Jackson, Madison County, Tennessee. The site, which is approximately 60 acres in size, is bounded on the north by Central Creek, on the east by industrial properties, on the south by the Seaboard Railroad and the South Fork Forked Deer River, and on the west by Central Creek.

The ACW site is on the alluvial plain of the South Fork Forked Deer River, the major stream draining the Jackson area. The river flows from southeast to northwest where it passes near the southwestern corner of the site (fig. 1). Central Creek, a minor tributary to the South Fork Forked Deer River, flows generally westward from an urban area in west Jackson, through a commercial and industrial area, and along part of the northern border of the site. Near the northwestern corner of the site, the creek turns approximately 90 degrees, flows southeastward along the site's western border, and enters the South Fork Forked Deer River near the southwestern corner of the site.

The terrain at the ACW site is flat except for the relief provided by the stream channels, which is about 15 feet in the area. Land-surface altitudes range from about 340 feet above sea level along the South Fork Forked Deer River to about 350 feet near the northeastern corner of the site. The site is partially protected from flooding by levees on the west and south.

Nearby areas to the west and south of the ACW site--called "offsite areas" for purposes of this report--where the ground-water investigation was conducted are on the swampy alluvial plain of the South Fork Forked Deer River and are subject to seasonal flooding. These areas are separated from the site by Central Creek and the embankment of the Seaboard Railroad. Access to the offsite areas is along a utility line right-of-way that crosses the alluvial plain for a distance of about 1/2 mile from improved roads. For these reasons, the offsite areas generally are accessible only during dry times of the year.

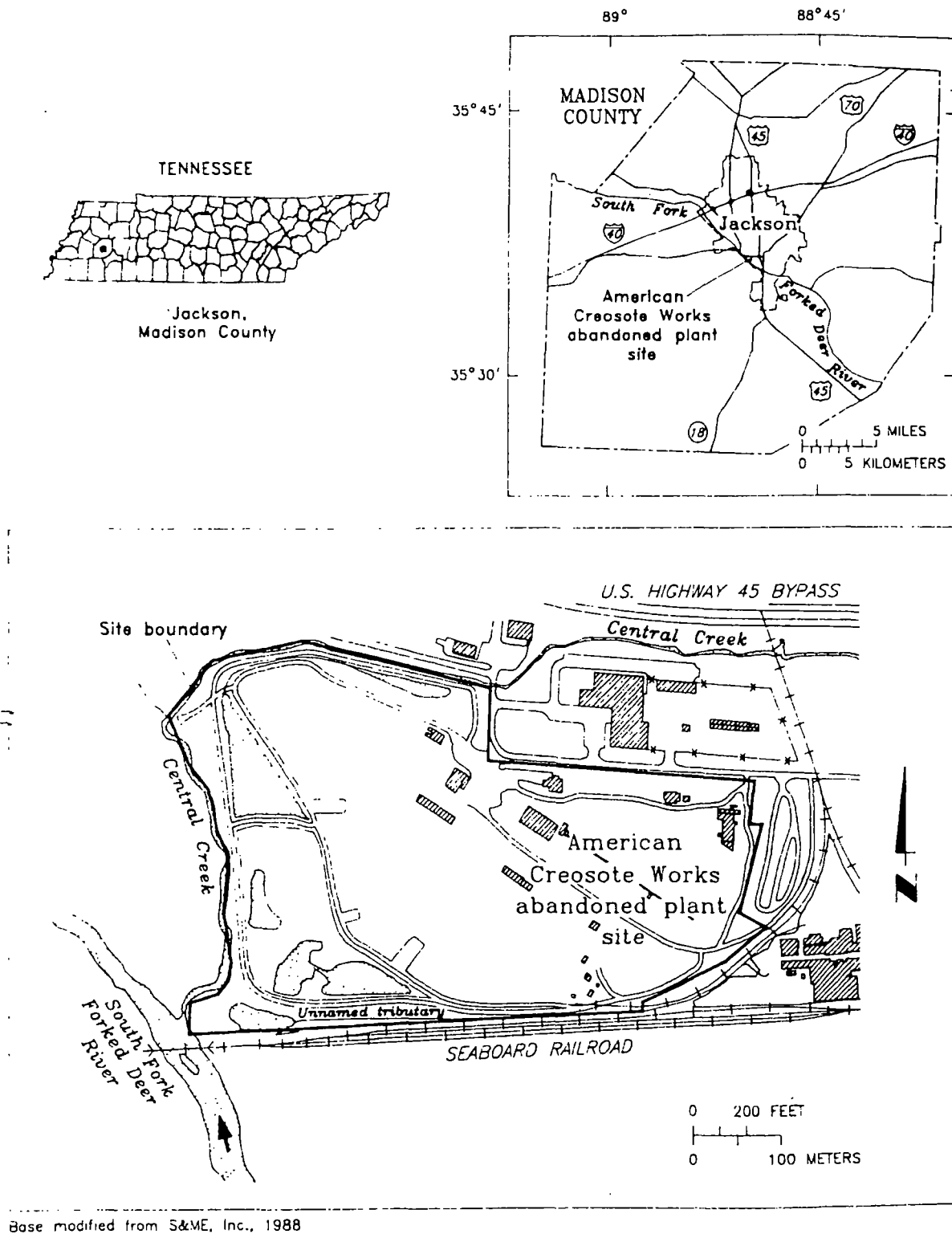


Figure 1. Location of the American Creosote Works abandoned plant site at Jackson, Tennessee.

HYDROGEOLOGY

The ACW site is located on the eastern limb of the Mississippi embayment, a broad structural trough or syncline that plunges southward along an axis that approximates the Mississippi River (Cushing and others, 1964). This syncline is filled with a few thousand feet of unconsolidated to semiconsolidated sediments comprising formations of Cretaceous and Tertiary age. These formations dip gently westward into the embayment and southward down the axis. Overlying the Cretaceous and Tertiary sediments in many areas are the fluvial deposits, loess, and alluvium of Tertiary(?) and Quaternary age. Post-Cretaceous geologic units underlying the ACW site are the Clayton Formation, Porters Creek Clay, Old Breastworks Formation, and Fort Pillow Sand of Tertiary age and the alluvium of Quaternary age (table 1).

Aquifer Description and Structural Relations

The Fort Pillow Sand and the alluvium consist primarily of sand with silt and clay lenses at various stratigraphic horizons. These units constitute the Fort Pillow aquifer (Parks and Carmichael, 1989) and the alluvial aquifer. In the area of the ACW site, the Fort Pillow and alluvial aquifers are not separated by a confining unit of any significant thickness or areal extent. However, because differences in silt and clay content in the sands affect contaminant migration in the subsurface beneath the ACW site, the Fort Pillow and alluvial aquifers are treated as separate aquifers in this report.

The uppermost alluvium consists primarily of clay and silt with some interbedded fine sand and serves as a relatively thin (0 to 20 feet thick) upper confining unit for the alluvial and Fort Pillow aquifers. The Clayton Formation and the Porters Creek Clay consist predominantly of clay and serve as a relatively thick (about 215 feet thick) lower confining unit separating the Fort Pillow aquifer from the deeper McNairy aquifer (table 1). The Old Breastworks Formation, between the Porters Creek Clay and the Fort Pillow Sand, consists primarily of very fine to fine sand with clay interbeds and may serve

more as a part of the lower confining unit than as an aquifer.

Nine stratigraphic test holes (table 2) were drilled through the alluvium, Fort Pillow Sand, and Old Breastworks Formation into the Porters Creek Clay at onsite stations 4, 6, and 7 and offsite stations OSGW1 through OSGW6 (fig. 2). Lithologic descriptions from samples collected and the geophysical logs made in these test holes are given in Appendix 2.

The boundary between the top of the Porters Creek Clay and the base of the overlying Old Breastworks Formation (where present) or Fort Pillow Sand is the most distinctive contact encountered in the stratigraphic test holes drilled at the three onsite and six offsite stations. The structure-contour map (fig. 2) of the top of the Porters Creek Clay indicates that its contact with the overlying Old Breastworks Formation or Fort Pillow Sand has an approximate dip of 20 to 30 feet per mile to the southwest beneath the central and western parts of the ACW site. In the northeast corner of the ACW site, the altitude of the top of the Porters Creek Clay in stratigraphic test hole Md:G-326 was about 35 feet lower than in the eight other test holes (fig. 2, table 3). This anomaly is interpreted to be relief (perhaps, a channel feature) on an erosional surface at the top of the Porters Creek Clay. Russell and Parks (1975, p. B24) determined that relief on this surface (contact between the Porters Creek Clay and Wilcox Formation in their report) locally is as much as 50 feet in the outcrop area in western Tennessee.

The anomaly in altitude of the top of the Porters Creek Clay at the ACW site could be the result of a fault. Evidence for a fault, however, is equivocal. Layers of rock (claystone or siliceous sandstone) interbedded with silty clay or silty sand that were encountered in the Porters Creek Clay near the bottoms of test holes Md:G-326, Md:G-360, and Md:G-362 (fig. 3, Appendix 2) may represent a continuous unit in the Porters Creek Clay underlying the site. If so, the difference in altitude of the top of the Porters Creek Clay in test hole Md:G-326 and the other test holes supports the hypothesis that the anomaly is the result of relief on an erosional surface.

Table 1. Post-Cretaceous geologic units underlying the American Creosote Works abandoned plant site at Jackson, Tennessee

[Compiled from lithologic and geophysical logs of test holes drilled at the site and at the University of Tennessee Agricultural Experiment Station 1 1/2 miles northwest, and reports by Schneider and Blankenship (1950), Milhous (1959), Parks (1968), Russell and Parks (1975), and Parks and Carmichael (1989)]

System	Series	Group	Stratigraphic unit	Thickness (in feet)	Lithology
Quaternary	Holocene and Pleistocene		Alluvium (Alluvial aquifer)	30-40	Sand, silt, clay, and gravel. Underlies the alluvial plain of the South Fork Forked Deer River. Upper part consists of clay, silt, and fine sand; lower part consists of fine to coarse sand containing some gravel.
Tertiary	Eocene	Wilcox	Fort Pillow Sand (Fort Pillow aquifer)	90-135	Sand, silt, clay, and minor lignite. Consists of lenses of medium to coarse and fine to medium sand with lenses of silt and clay at various stratigraphic horizons.
	?		Old Breastworks Formation	0-35	Sand, silt, clay, and lignite. Con- sists of fine to medium and fine to very fine sand with lenses of silt, clay, and lignite.
	Paleocene	Midway	Porters Creek Clay	175	Clay and lenses of sand. Consists of a widespread and thick body of clay with some interbeds of fine sand. Locally contains thin beds of claystone in upper part. Serves as the principal confining layer separating the Fort Pillow aquifer from the McNairy aquifer.
			Clayton Formation	40	Clay, silt, and sand. Overlies the Owl Creek Formation and the McNairy Sand of Cretaceous age.

Table 2. Stratigraphic test holes drilled at onsite stations 4, 6, and 7 and offsite stations OSGW1 through OSGW6 and depth to and altitude of top of the Porters Creek Clay at the American Creosote Works abandoned plant site

[USGS, U.S. Geological Survey]

Station number (see fig. 2)	USGS local well number	Date completed	Altitude of land surface above sea level, in feet	Depth to top of Porters Creek Clay below land surface, in feet	Altitude of top of Porters Creek Clay above sea level, in feet	Total depth of test hole, in feet
Onsite stations						
4	Md:G-365	11-19-91	344	156	188	223
6	Md:G-366	11-20-91	346	157	189	216
7	Md:G-326	05-15-90	348	194	154	245
Offsite stations						
OSGW1	Md:G-359	10-08-91	343	154	189	218
OSGW2	Md:G-360	10-10-91	342	160	182	240
OSGW3	Md:G-361	10-22-91	341	157	184	236
OSGW4	Md:G-362	10-29-91	343	160	183	236
OSGW5	Md:G-363	10-27-91	342	158	184	228
OSGW6	Md:G-364	10-25-91	342	158	184	229

Aquifer Characteristics and Ground-Water Flow

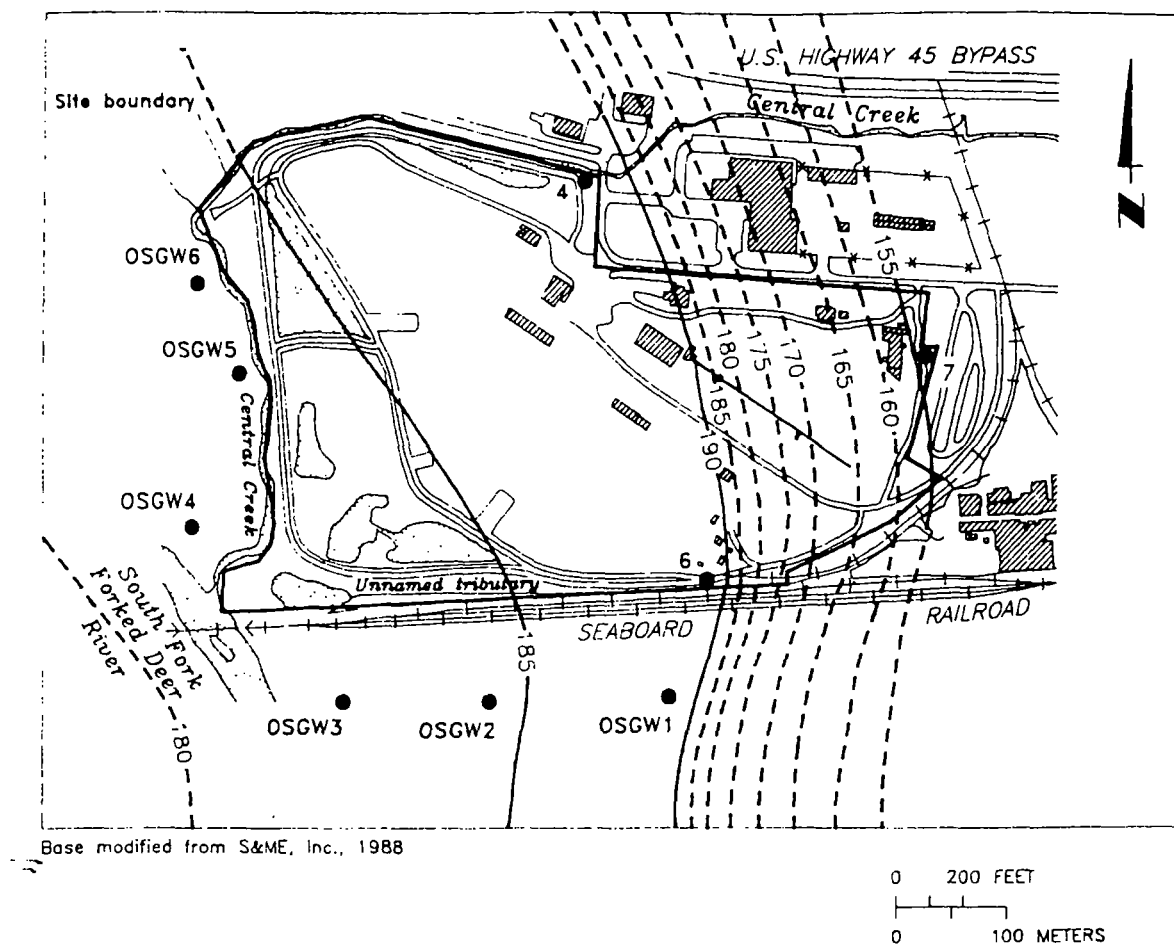
Water levels were measured in 33 onsite wells in March and October 1990 and in 31 onsite and 36 offsite wells in October 1992 (fig. 4; table 3). These data indicate that water levels generally are high throughout the year, ranging from about 1 to 10 feet below land surface. Onsite and offsite clusters of monitoring wells are screened at depths of about 8 to 41 feet below land surface in the alluvial aquifer and 36 to 154 feet below land surface in the Fort Pillow aquifer (table 3). The Fort Pillow and alluvial aquifers are semi-confined beneath the ACW site.

Water levels measured in the onsite and offsite monitoring wells during October 1992 (table 3) were used to prepare potentiometric-surface maps of the alluvial aquifer and the Fort Pillow aquifer. These maps (fig. 5) indicate that relatively small differences in hydraulic head exist between these aquifers. Where wells are in clusters, water levels in the shallowest wells in the alluvial aquifer and the deepest wells in the Fort Pillow aquifer were used for preparation of the maps (fig. 5).

Water levels range from about 340 feet above sea level in wells at the higher altitudes at the northeastern part of the area to about 334 feet above sea level in the southwestern part near the South Fork Forked Deer River (fig. 5). Thus, the horizontal component of ground-water flow is from northeast to southwest across the ACW site toward the river (fig. 5).

Water levels were recorded continuously since February 21, 1990, in well Md:G-284, (fig. 5) screened from 25 to 35 feet in the alluvial aquifer, and since May 30, 1990, in well Md:G-326 (fig. 5) screened from 134 to 154 feet in the Fort Pillow aquifer to determine seasonal water-level fluctuations. Hydrographs for these wells (fig. 6) show that water levels in the shallow and deep zones fluctuate similarly as if the wells are screened in a single aquifer. Hydraulic head differences in wells Md:G-284 and Md:G-326 (fig. 6) are less than 0.5 foot and generally are higher in the alluvial aquifer than in the Fort Pillow aquifer, indicating downward movement of ground water (recharge) beneath this part of the ACW site.

Vertical hydraulic gradients locally are somewhat complex and vary upward or downward among wells in clusters and among clusters, based



EXPLANATION

- 180— STRUCTURE CONTOUR--Shows altitude of top of the Porters Creek Clay. Dashed where approximately located. Contour interval 5 feet. Datum is sea level
- 6 ● ONSITE STATION AT WHICH STRATIGRAPHIC TEST HOLE WAS DRILLED
- OSGW3 OFFSITE STATION AT WHICH STRATIGRAPHIC TEST HOLE WAS DRILLED

Figure 2. Location of onsite stations 4, 6, and 7, offsite stations OSGW1 through OSGW6 where stratigraphic test holes were drilled, and altitude of top of Porters Creek Clay.

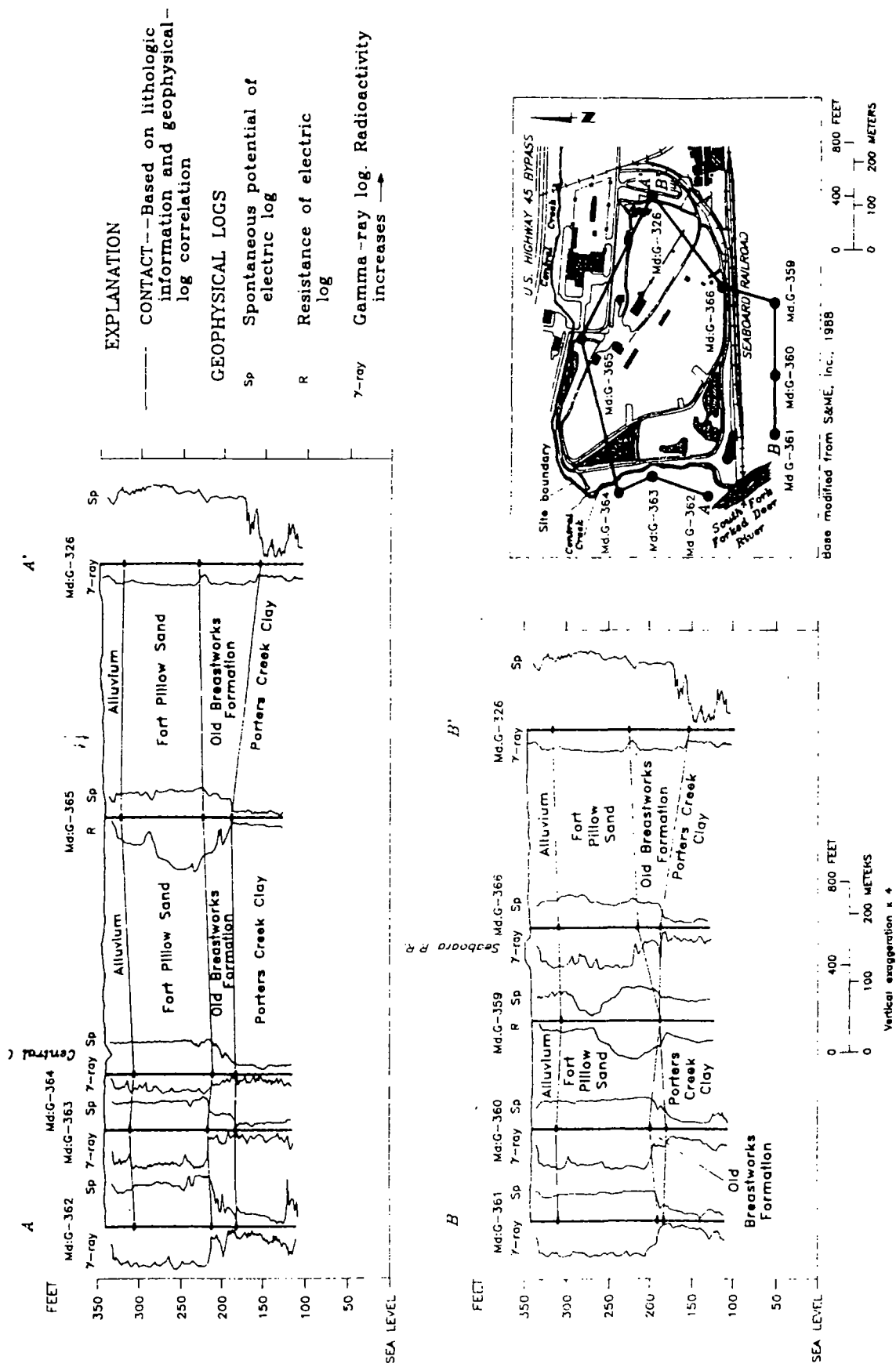
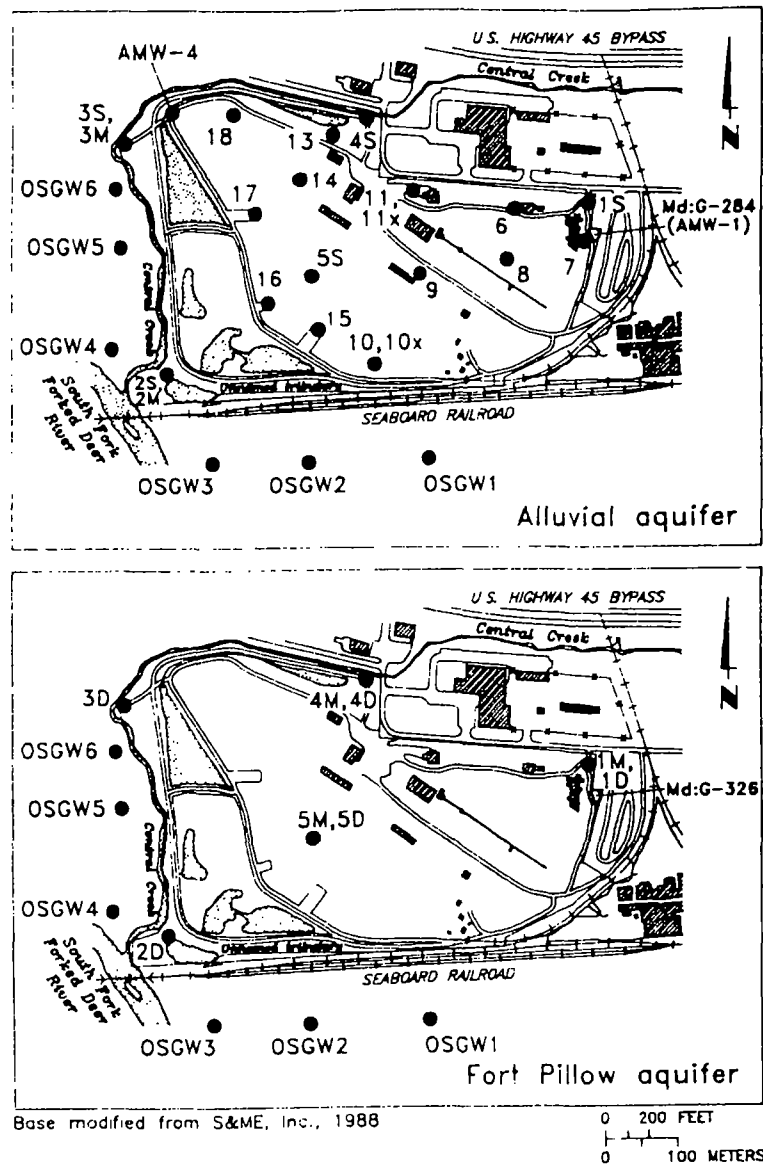


Figure 3. Hydrogeologic sections A-A' and B-B' through the area of the American Creosote Works abandoned plant site.



EXPLANATION

- 2D ● WELL IN WHICH WATER LEVEL WAS MEASURED AND WELL NUMBER
- Md:G-326 WELL WITH CONTINUOUS WATER-LEVEL RECORDER AND WELL NUMBER
- OSGW3 OFFSITE STATION AND NUMBER--Six wells at each station. Wells 1-3 screened in the alluvial aquifer and wells 4-6 screened in the Fort Pillow aquifer. For example, OSGW1-1 is screened in the alluvial aquifer and OSGW1-4 is the shallowest of the three wells screened in the Fort Pillow aquifer

Figure 4. Location of wells screened in the alluvial and Fort Pillow aquifers in which water levels were measured in March 1990, October 1990, and October 1992.

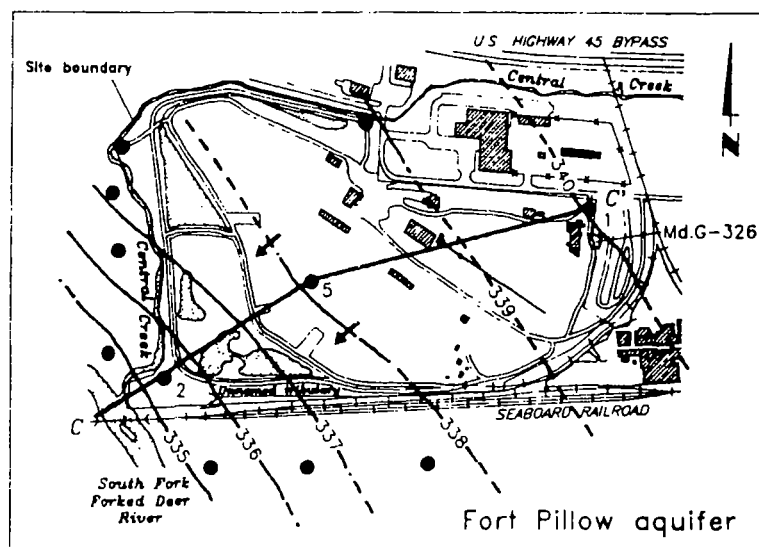
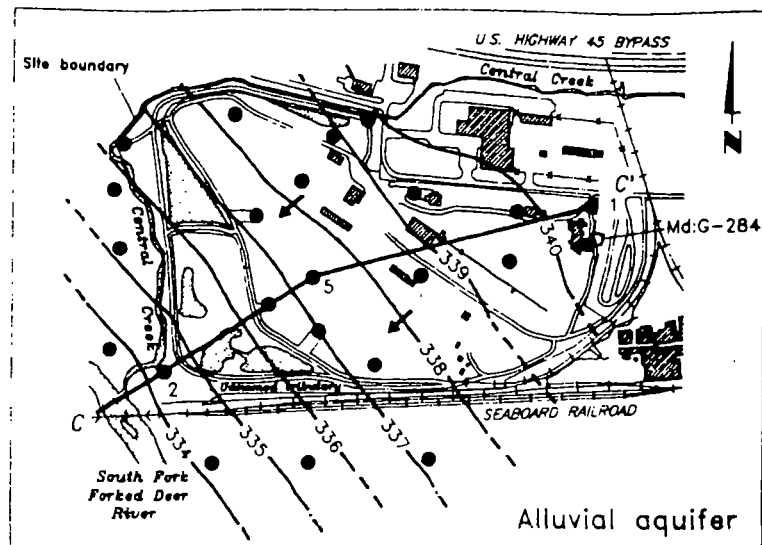
3. Well descriptions and water levels measured in onsite and offsite wells at the American Creosote Works
 abandoned plant site in March 1990, October 1990, and October 1992

[S, U.S. Geological Survey; —, indicates no measurement, because well had not been installed]

Well numbers		Altitude of land surface above sea level, in feet	Screened interval below land surface, in feet	Aquifer in which screened	Water-level below land surface		
Object and map	USGS local for Tennessee				Depth on 3-22-90, in feet	Depth on 10-17-90, in feet	Depth on 10-21-92, in feet
Onsite wells							
FW-1	Md:G-284	348	25 - 35	Alluvial	5.90	8.18	8.50
FW-4	Md:G-287	344	20 - 25	Alluvial	7.43	9.42	no measurement
	Md:G-289	350	20.5 - 25.5	Alluvial	7.00	9.41	9.63
	Md:G-290	350	54.5 - 59.5	Fort Pillow	7.33	9.64	9.92
	Md:G-291	350	112 - 122	Fort Pillow	7.33	9.59	9.93
	Md:G-293	342	12 - 17	Alluvial	5.20	7.65	7.44
	Md:G-294	342	29.5 - 34.5	Alluvial	5.42	7.87	7.79
	Md:G-295	342	116.5 - 126.5	Fort Pillow	4.30	6.52	6.44
	Md:G-297	343	8.5 - 13.5	Alluvial	4.95	6.56	6.54
	Md:G-298	343	32.5 - 37.5	Alluvial	4.85	6.52	6.36
	Md:G-299	343	125.5 - 135.5	Fort Pillow	3.80	5.98	5.88
	Md:G-301	347	16.5 - 21.5	Alluvial	5.10	7.29	7.12
	Md:G-302	347	52.5 - 57.5	Fort Pillow	4.97	7.36	7.22
	Md:G-303	347	117.5 - 127.5	Fort Pillow	5.94	8.15	8.22
	Md:G-305	342	14.5 - 19.5	Alluvial	2.32	4.63	4.79
	Md:G-306	342	57 - 62	Fort Pillow	1.78	4.11	4.52
	Md:G-307	342	100.5 - 110.5	Fort Pillow	1.36	3.60	3.68
	Md:G-309	348	16.5 - 21.5	Alluvial	5.91	8.20	8.44
	Md:G-310	349	14 - 19	Alluvial	6.07	8.34	8.67
	Md:G-311	347	14 - 19	Alluvial	4.66	7.00	7.23
	Md:G-312	346	15 - 20	Alluvial	4.86	7.30	7.43
	Md:G-313	343	12.5 - 17.5	Alluvial	2.98	5.44	5.52
K	Md:G-323	343	11 - 16	Alluvial	2.50	4.93	5.05
	Md:G-314	347	17 - 21.5	Alluvial	5.15	7.44	7.47
K	Md:G-324	347	17 - 22	Alluvial	5.00	7.28	7.40
	Md:G-315	346	14.5 - 19.5	Alluvial	4.72	6.66	no measurement
	Md:G-316	344	14.5 - 19.5	Alluvial	5.69	5.06	5.07
	Md:G-317	344	14.5 - 19.5	Alluvial	3.81	5.48	5.17
	Md:G-318	342	13 - 18	Alluvial	7.00	3.22	4.98
	Md:G-319	342	12 - 17	Alluvial	2.73	5.06	5.15
	Md:G-320	342	9.5 - 14.5	Alluvial	2.15	4.36	4.45
	Md:G-321	344	14.5 - 19.5	Alluvial	3.38	5.49	5.54
nc	Md:G-326	348	134 - 154	Fort Pillow	--	8.10	8.39

Table 3. Well descriptions and water levels measured in onsite and offsite wells at the American Creosote Works abandoned plant site in March 1990, October 1990, and October 1992--Continued

Well numbers		Altitude of land surface above sea level, in feet	Screened interval below land surface, in feet	Aquifer in which screened	Water-level below land surface		
Project and map	USGS local for Tennessee				Depth on 3-22-90, in feet	Depth on 10-17-90, in feet	Depth on 10-21-92, in feet
Offsite wells							
OSGW1-1	Md-G-367	343	13 - 18	Alluvial	--	--	5.63
OSGW1-2	Md-G-368	343	19 - 24	Alluvial	--	--	5.20
OSGW1-3	Md-G-369	343	27 - 32	Alluvial	--	--	5.57
OSGW1-4	Md-G-370	343	42 - 52	Fort Pillow	--	--	5.25
OSGW1-5	Md-G-371	343	92 - 102	Fort Pillow	--	--	5.53
OSGW1-6	Md-G-372	343	128 - 138	Fort Pillow	--	--	5.26
OSGW2-1	Md-G-373	342	10 - 15	Alluvial	--	--	6.27
OSGW2-2	Nd-G-374	342	17 - 22	Alluvial	--	--	5.92
OSGW2-3	Md-G-375	342	24 - 29	Alluvial	--	--	5.75
OSGW2-4	Md-G-376	342	62 - 72	Fort Pillow	--	--	5.42
OSGW2-5	Md-G-377	342	92 - 102	Fort Pillow	--	--	4.88
OSGW2-6	Md-G-378	342	127 - 137	Fort Pillow	--	--	5.30
OSGW3-1	Md-G-379	341	9 - 14	Alluvial	--	--	6.80
OSGW3-2	Md-G-380	341	15 - 20	Alluvial	--	--	7.25
OSGW3-3	Md-G-381	341	24 - 29	Alluvial	--	--	7.43
OSGW3-4	Md-G-382	341	36 - 46	Fort Pillow	--	--	7.25
OSGW3-5	Md-G-383	341	68 - 78	Fort Pillow	--	--	5.85
OSGW3-6	Md-G-384	341	138 - 148	Fort Pillow	--	--	5.58
OSGW4-1	Md-G-385	343	10 - 15	Alluvial	--	--	9.44
OSGW4-2	Md-G-386	343	22 - 27	Alluvial	--	--	9.79
OSGW4-3	Md-G-387	343	36 - 41	Alluvial	--	--	9.55
OSGW4-4	Md-G-388	343	48 - 58	Fort Pillow	--	--	8.52
OSGW4-5	Md-G-389	343	79 - 89	Fort Pillow	--	--	8.04
OSGW4-6	Md-G-390	343	117 - 127	Fort Pillow	--	--	6.73
OSGW5-1	Md-G-391	342	12 - 17	Alluvial	--	--	6.75
OSGW5-2	Md-G-392	342	19 - 24	Alluvial	--	--	6.75
OSGW5-3	Md-G-393	342	27 - 32	Alluvial	--	--	6.80
OSGW5-4	Md-G-394	342	40 - 50	Fort Pillow	--	--	6.47
OSGW5-5	Md-G-395	342	83 - 93	Fort Pillow	--	--	6.01
OSGW5-6	Md-G-396	342	113 - 123	Fort Pillow	--	--	5.73
OSGW6-1	Md-G-397	342	10 - 15	Alluvial	--	--	6.40
OSGW6-2	Md-G-398	342	19 - 24	Alluvial	--	--	6.21
OSGW6-3	Md-G-399	342	27 - 32	Alluvial	--	--	6.38
OSGW6-4	Md-G-400	342	50 - 60	Fort Pillow	--	--	6.00
OSGW6-5	Md-G-401	342	82 - 92	Fort Pillow	--	--	6.40
OSGW6-6	Md-G-402	342	120 - 130	Fort Pillow	--	--	6.20



Base modified from S&WE, Inc., 1988

0 200 FEET
0 100 METERS

EXPLANATION

- 335 — POTENTIOMETRIC CONTOUR—Shows altitude at which water level stood in wells. Dashed where approximately located. Contour interval 1 foot. Datum is sea level
- ← DIRECTION OF GROUND-WATER FLOW
- C—C' LINE OF SECTION—(See figure 7)
- WELL IN WHICH WATER LEVEL WAS MEASURED
- WELL WITH CONTINUOUS WATER-LEVEL RECORDER AND WELL NUMBER
Md.G-326
- STATION WITH WELL CLUSTER AND NUMBER
2

re 5. Potentiometric surfaces in the alluvial and Fort Pillow aquifers, October 1992, and location of wells G-284 and Md.G-326.

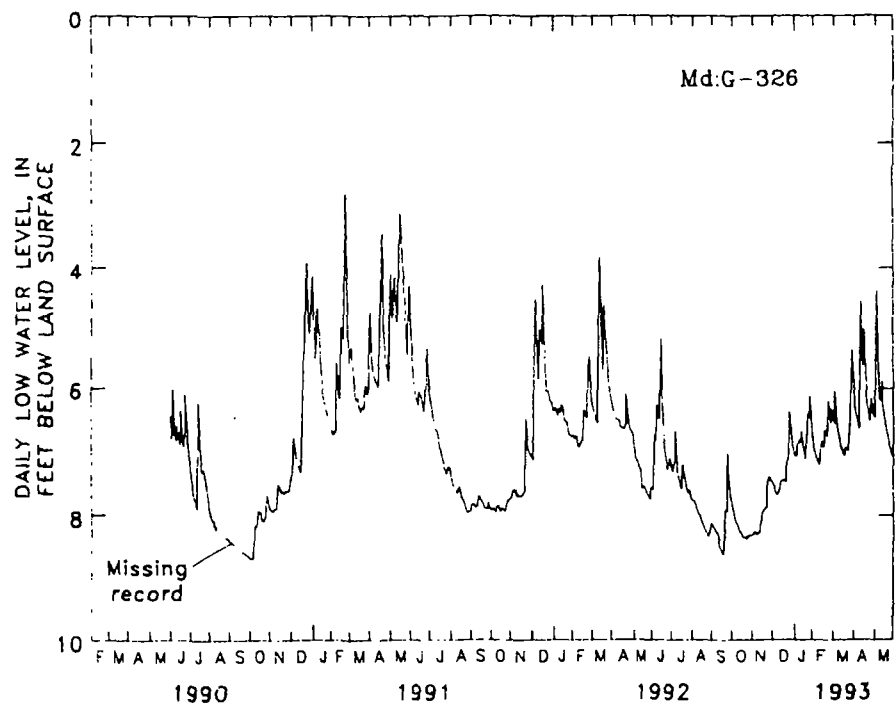
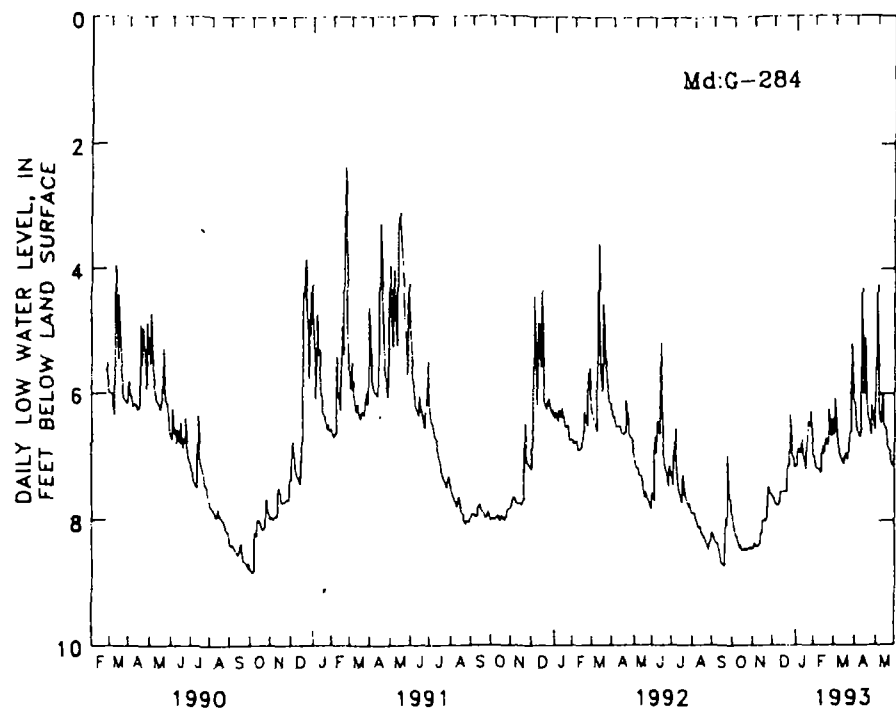


Figure 6. Water levels recorded in well Md:G-284 screened in the alluvial aquifer and well Md:G-326 screened in the Fort Pillow aquifer, February 1990 through May 1993, at the American Creosote Works abandoned plant site.

water-level measurements (table 3). Water levels generally are slightly higher in the shallower wells than in the deeper wells at onsite stations 1 (wells 1S, 1M, and 1D) and 4 (wells 4S, 4M, and 4D) (fig. 4). These differences in hydraulic head indicate a downward hydraulic gradient in the northeastern and northern parts of the ACW site for recharge to the aquifers. Water levels generally are slightly higher in the deeper wells than in the shallower wells at onsite station 2 (wells 2M, and 2D), station 3 (wells 3S, 3M, and 3D), and station 5 (wells 5S, 5M, and 5D) (fig. 4). Water levels also are higher in the deeper wells than in the shallower wells at offsite stations OSGW1 through OSGW6 (fig. 4). These differences in hydraulic head indicate upward flow of water in the northwestern, west-central, and southern parts of the ACW site and in nearby offsite areas and discharge from the aquifers to the South Forked Deer River. A generalized hydrogeologic section from station 1, through stations 5 and 6 to the South Forked Deer River depicts groundwater flow at the ACW site (fig. 7) for potentiometric conditions during October 1992. Hydraulic conductivities for the alluvial and Fort Pillow aquifers were determined by computer analysis of filling-rates of the Hydrocone tool for short intervals during the ground-water sampling as part of the DPT work at onsite stations (Parks and others, 1993) and at offsite stations OSGW1 through OSGW6 (table 4). Forty measurements of hydraulic conductivity for the alluvial aquifer ranged from 0.195 to 46.8 ft/day, and three measurements of hydraulic conductivity for the Fort Pillow aquifer ranged from 0.009 to 26.4 ft/day. These ranges in hydraulic conductivity measurements indicate considerable heterogeneity in the materials that make up the alluvial and Fort Pillow aquifers.

Average flow velocities of ground water in the alluvial and Fort Pillow aquifers were calculated using an equation derived from a combination of Darcy's law and the velocity equation of hydraulics (Manning, 1983):

$$v = \frac{Kdh}{ndl}$$

where,

- v is the Darcian velocity, which is the average velocity of the entire cross-sectional area, in feet per day;
- K is the hydraulic conductivity, in feet per day;
- dh/dl is the hydraulic gradient, in foot per foot; and
- n is the porosity, in percent by volume.

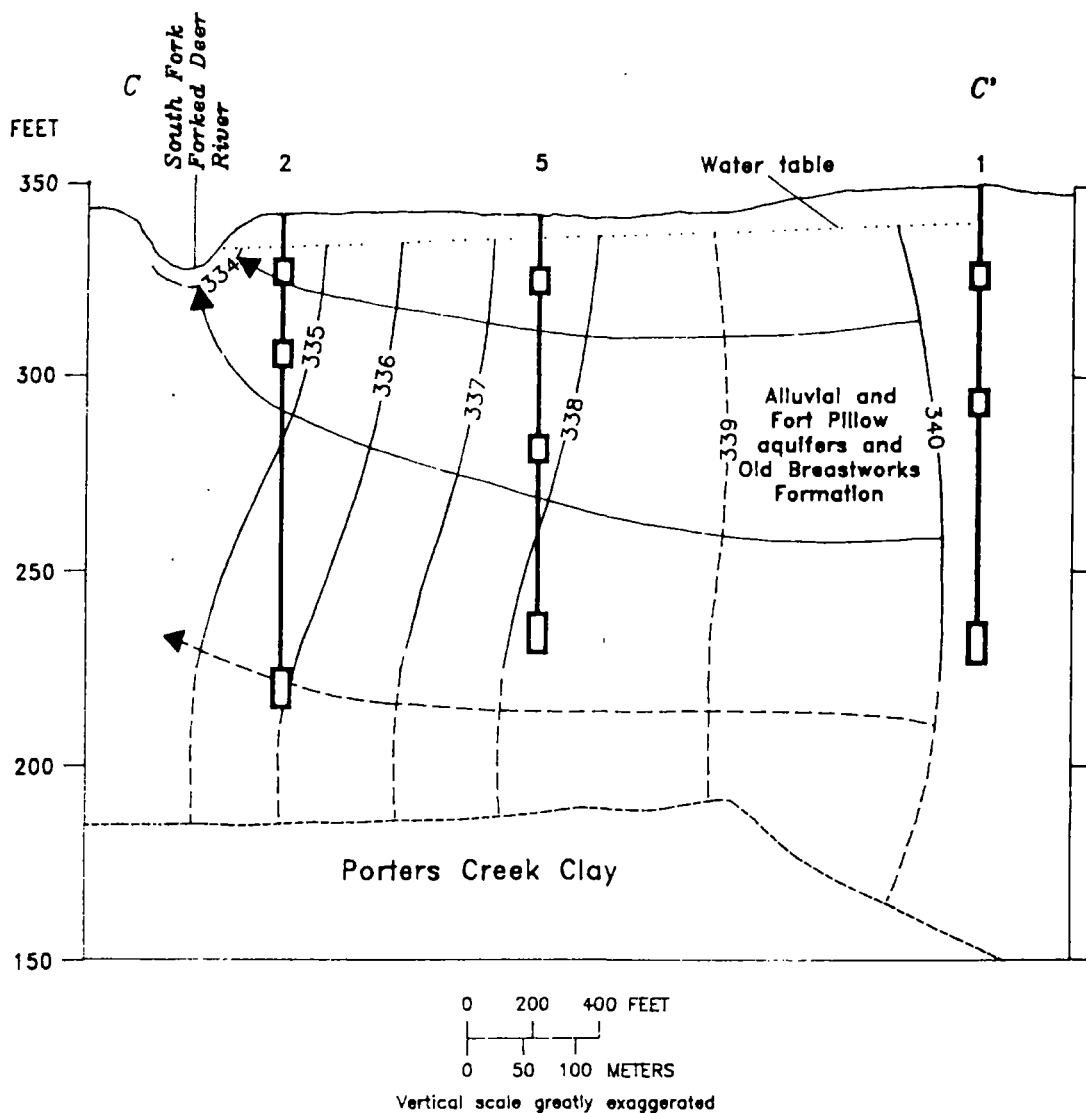
Hydraulic gradients estimated from the potentiometric surface maps (fig. 5) and median values of hydraulic conductivity determined from the DPT results at onsite (Parks and others, 1993) and offsite (table 4) stations were used in the calculations. Porosity was assumed to be 20 percent for both aquifers.

For the alluvial aquifer, an average groundwater flow velocity was calculated using a median hydraulic conductivity of 2.46 ft/day and an estimated hydraulic gradient of 0.0038 foot per foot. These values indicate an average flow velocity of about 0.047 foot per day (17 feet per year). Minimum and maximum values for hydraulic conductivity substituted into this equation indicate minimum and maximum average flow velocities in the alluvial aquifer of about 1.4 and 325 feet per year.

For the Fort Pillow aquifer, an average groundwater flow velocity was calculated using a median hydraulic conductivity of 2.03 ft/day and an estimated hydraulic gradient of 0.0027 foot per foot. These values indicate an average flow velocity of about 0.027 foot per day (10 feet per year). Minimum and maximum values of hydraulic conductivity substituted into the equation indicate minimum and maximum average flow velocities in the Fort Pillow aquifer of about 0.04 and 130 feet per year.

GROUND-WATER QUALITY

For this investigation, ground-water samples were collected at 6 offsite stations with the DPT Hydrocone tool and from 36 wells installed at these stations (6 wells at each station) to determine the extent and magnitude of offsite contamination from the ACW site. Ground-water samples collected with the DPT Hydrocone tool were analyzed for polynuclear aromatic hydrocarbons (PAH's),



EXPLANATION

- 335— EQUIPOTENTIAL LINE--Shows altitude at which water level would have stood in tightly cased wells. Dashed where approximately located. Interval is 1 foot. Datum is sea level
- ← --- GENERALIZED FLOW LINE--Dashed where flow direction is uncertain. Arrow shows direction of flow
- 2 ONSITE STATION WITH WELL CLUSTER
- SCREENED INTERVALS OF WELLS IN CLUSTERS

Figure 7. Hydrogeologic section C-C' showing generalized ground-water flow beneath the American Creosote Works abandoned plant site. (See figure 5 for location of hydrogeologic section.)

ble 4. Water levels, hydraulic conductivities, lithologies, and relative densities of sediment in the alluvial aquifer at site stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant site

Water levels were calculated from hydrostatic-pressure data from the Hydrocone tool; hydraulic conductivities were calculated from hydrostatic-pressure data and filling rates of the Hydrocone tool; lithology was derived from computer analysis of point-stress and friction data from the Hydrocone tool; relative densities of sediment were calculated from the piezocone point-stress data and are given in units equivalent to numbers of blows per foot as measured by a standard penetration test conducted by driving a split-spoon sampler out the bottom of a hollow-stem auger with a 140-pound hammer]

Station number	Hydrocone depth below land surface, in feet	Water level below land surface, in feet	Hydraulic conductivity, in feet per day	Lithology	Relative density of sediment
SGW1	15 - 16	4.5	0.347	Fine sand	40
	27 - 28	4.5	46.8	Fine sand	19
	29 - 30	4.5	6.81	Clayey fine sand	40
	30.5 - 31.5	4.5	.778	Silty to clayey fine sand	45
SGW2	9 - 10	5	.289	Fine sand	30
	14 - 15	5	5.51	Silty fine sand	15
	16 - 17	5	1.11	Dense or cemented sands	50
	21 - 22	5	1.94	Silty fine sand	25
	23 - 24	5	1.44	Dense or cemented sands	45
	28 - 29	5	1.83	No data	
SGW3	13.5 - 14.5	6.5	.773	Fine sand	31
	19 - 20	6.5	3.71	Fine sand	29
	23 - 24	6.5	.888	Fine sand	37
	28 - 29	6.5	2.54	No data	-
SGW4	14 - 15	7.5	9.55	Silty to clayey fine sand	35
	19 - 20	7.5	.255	Fine sand	29
	22 - 23	7.5	3.56	Fine sand	45
	35 - 36	7.5	.373	Dense or cemented sands	32
	40 - 41	7.5	.735	Fine sand	21
SGW5	14 - 15	6	1.23	Fine sand	55
	16 - 17	6	2.39	Sandy clay	18
	23 - 24	6	1.77	Fine sand	41
	31 - 32	6	2.16	Fine sand	33
SGW6	11 - 12	6	9.89	Silty to clayey fine sand	18
	14 - 15	6	20.8	Silty to clayey fine sand	23
	17 - 18	6	11.5	Silty fine sand	24
	21 - 22	6	10.5	Silty to clayey fine sand	20
	26 - 27	6	4.32	Silty fine sand	27
	30 - 31	6	9.83	Fine sand	42

phenolic compounds (including PCP), and nitrogen-containing heterocyclic compounds. The DPT samples also were analyzed for selected volatile organic compounds (VOC's). Water samples pumped from the 36 wells were analyzed for selected VOC's and semi-volatile organic compounds (SVC's). Samples from these wells also were analyzed for trace elements, major inorganic constituents, and water-quality characteristics.

Onsite ground-water-quality data are summarized herein to identify possible contaminants and to provide a geochemical basis for comparison to offsite ground-water contaminant concentrations. Data for organic compounds are from an onsite evaluation of subsurface exploration, sampling, and water-quality-analysis methods (Parks and others, 1993). Data for trace elements are from the RI/FS for the ACW site (S&ME, Inc., 1988). Discussion of the transport and fate of organic constituents of creosote and related contaminants in ground water at the ACW site is based on results of investigations at the American Creosote Works abandoned plant site at Pensacola, Florida (Matraw and Franks, 1986).

In the discussion that follows (and in tables 8, 10, and 14), references are made to primary maximum contaminant levels (MCL's) in drinking water. The Tennessee Department of Environment and Conservation (TDEC) is the regulatory agency that determines these levels for the State of Tennessee (Tennessee Department of Environment and Conservation, 1993). The TDEC follows the primary MCL's established by the USEPA (U.S. Environmental Protection Agency, 1986, 1992). Therefore, for discussion of organic compounds and trace elements, reference is made to primary MCL's of the TDEC.

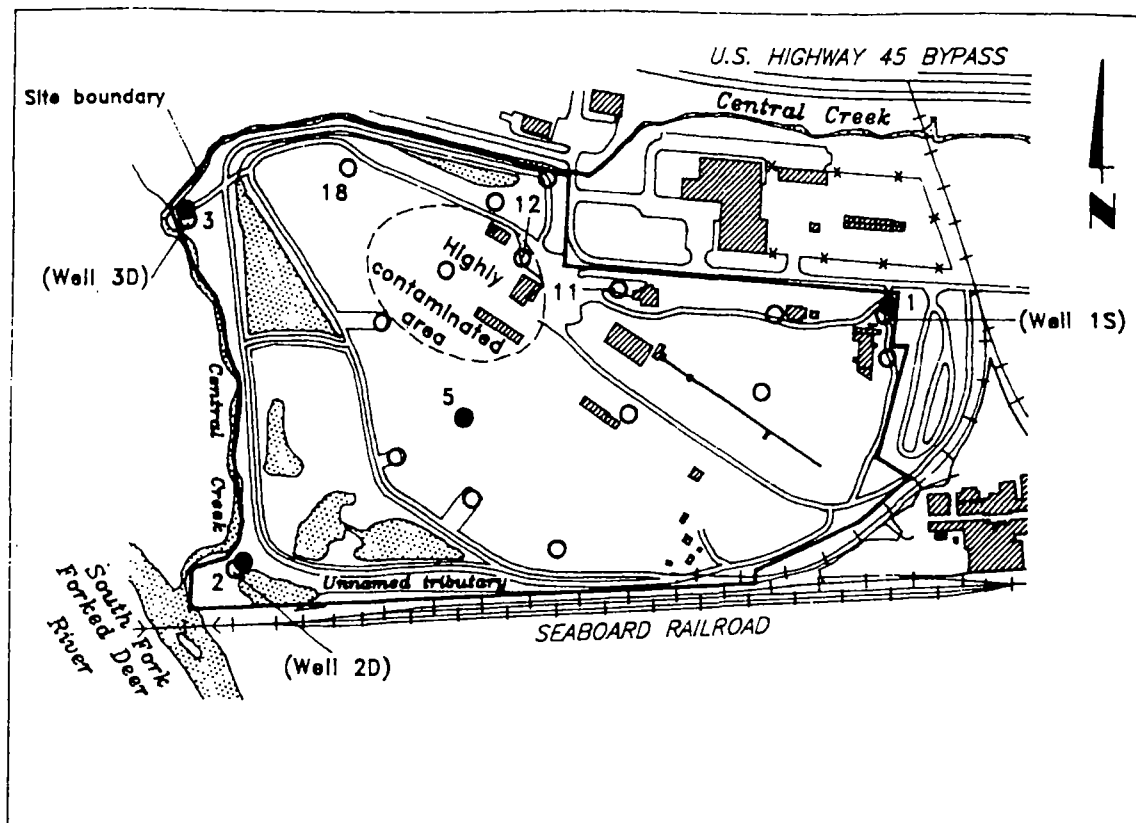
Onsite Water Quality

The physical and chemical nature of the contaminants in the subsurface beneath the ACW site is complex. Creosote, a coal-tar distillate used as a wood preservative, is a mixture of about 200 compounds, including PAH's, phenolic compounds, and nitrogen-containing heterocyclic compounds (Goerlitz, 1992; Goerlitz and others, 1985). Some time after 1950, PCP in a solvent of diesel fuel also was used in the wood-preserving processes

(Goerlitz, 1992, p. 338; Chapelle, 1993, p. 367). Diesel fuel contains soluble VOC's, including BTEX's (Chapelle, 1993, table 12.1). At the ACW site, contaminants from the wood-preserving processes have migrated into the subsurface as a non-aqueous phase liquid (NAPL) from onsite sources, such as waste lagoons and treatment areas. As the NAPL migrates, its composition and constituent concentrations change.

Physical and chemical processes that affect the NAPL as it migrates include: (1) partitioning of water-soluble organic compounds from the NAPL to ground water (Pereira and Rostad, 1986); (2) microbial degradation and transformation of creosote and related organic compounds (Baedecker and Lindsay, 1986; Godsy and Goerlitz, 1986; Ehrlich and others, 1982); (3) sorption of organic compounds onto clay mineral surfaces (Goerlitz and others, 1985); and, (4) dilution (Goerlitz, 1992). As an end result of these processes, soluble organic compounds have dissolved in ground water (aqueous phase) from the NAPL and have entered the alluvial and the Fort Pillow aquifers.

The most complete set of organic analyses available for interpretation of onsite ground-water quality were obtained from stations 2 and 5 (fig. 8), using HPLC and GC/PID methods of analysis in conjunction with the evaluation of subsurface exploration, sampling, and water-quality-analysis methods conducted at the ACW site (Parks and others, 1993). Four groups of organic compounds detected in ground-water samples collected at onsite stations 2 and 5 were: (1) PAH's, (2) phenolic compounds (including PCP), (3) nitrogen-containing heterocyclic compounds, and (4) VOC's, primarily BTEX (benzene, toluene, ethylbenzene and total xylenes) compounds (Parks and others, 1993). Although water-quality data were reported previously in the RI/FS report (S&ME, Inc., 1988), organic compound concentrations commonly were reported as "estimated concentrations" or concentrations "below high detection limits." These organic compound concentration data are incomplete for determination of the extent of ground-water contamination and are not summarized herein. However, trace element concentrations in water samples from wells were reported in the RI/FS (S&ME, Inc., 1988), and these data were considered in interpretations of onsite water quality.



Base modified from S&ME, Inc., 1988

EXPLANATION

- ONSITE STATION AND NUMBER--
3 wells at each station
- WELL AND NUMBER--Individual
well at station
- WELL AND NUMBER--Wells with
numbers are cited in the text

Figure 8. Location of onsite stations and wells where water-quality data were collected for the Remedial Investigation Feasibility Study and an evaluation of subsurface exploration, sampling, and water-quality-analysis methods. Data from S&ME, Inc., 1988, and Parks and others, 1993.

The organic compounds that best indicate subsurface contamination from the wood-preserving processes are PAH's, phenolic compounds including PCP, and nitrogen-containing heterocyclic compounds (Goerlitz and others, 1985; Goerlitz, 1992). These three groups of organic compounds were measured in ground-water samples collected with the DPT Hydrocone tool at the ACW site (Parks

and others, 1993). At station 5 (located nearest to the highly contaminated area), maximum concentrations of PAH's, phenolic compounds, and nitrogen-containing heterocyclic compounds were measured in ground-water samples from depths of 20 to 21 feet and 31 to 32 feet below land surface (fig. 9). At station 2 (located near the confluence of Central Creek and the South Fork Forked Deer

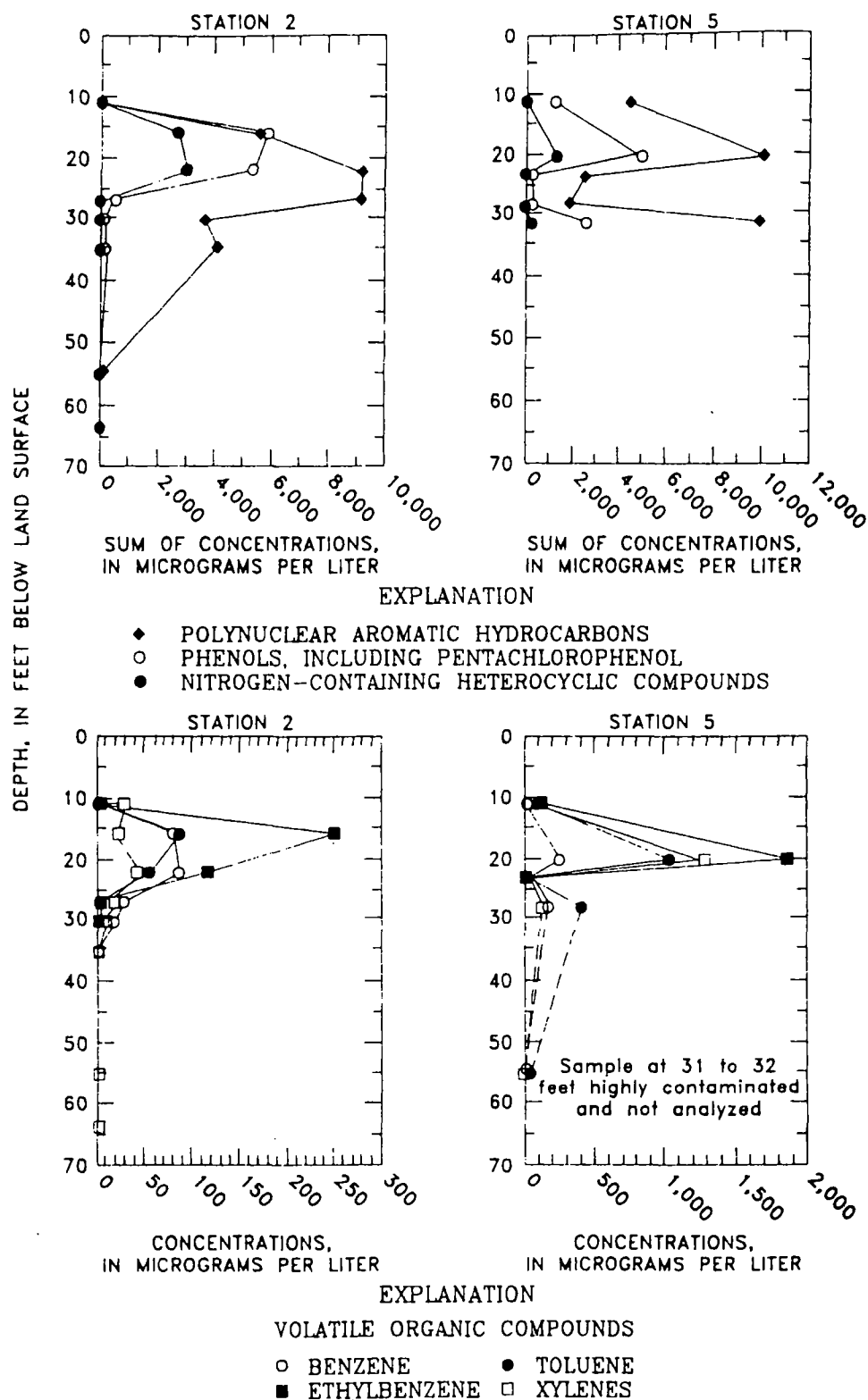


Figure 9. Relation of concentrations of polynuclear aromatic hydrocarbons, phenols (including pentachlorophenol), nitrogen-containing heterocyclic compounds, and volatile organic compounds in ground-water samples to depth of detection at onsite stations 2 and 5 at the American Creosote Works abandoned plant site.

er), maximum PAH concentrations were measured in ground-water samples from depths of 22 to 27 feet and 27 to 28 feet below land surface (fig. 9). Maximum phenolic and nitrogen-containing heterocyclic compound concentrations were measured in ground-water samples from somewhat shallower depths of 16 to 17 feet and 22 to 23 feet at station 2 (fig. 9).

Five PAH compounds detected in ground-water samples collected with the DPT Hydrocone tool from the alluvial aquifer at stations 2 and 5 were: benzothiophene, indene, naphthalene, 2-methylnaphthalene, and 1,2-dihydroacenaphthalene (Parks and others, 1993). The maximum concentration measured for each compound was 1,100 $\mu\text{g/L}$ for benzothiophene at station 5, 20-21 feet); 100 $\mu\text{g/L}$ (indene at station 5, 20-21 feet); 100 $\mu\text{g/L}$ (naphthalene at station 2, 30-35 feet); 100 $\mu\text{g/L}$ (2-methyl naphthalene at station 5, 12 feet and at station 2, 30-35 feet); and 1 $\mu\text{g/L}$ (1,2-dihydroacenaphthalene at station 5, 32 feet) (Parks and others, 1993).

Naphthalene was the only PAH compound detected onsite in ground-water samples collected with the DPT Hydrocone tool or from wells screened in the Fort Pillow aquifer. Naphthalene concentrations measured were 5 $\mu\text{g/L}$ at station 2 (16-65 feet), 2 $\mu\text{g/L}$ in a sample from well 2D at station 2 (116.5-126.5 feet), and 2 $\mu\text{g/L}$ in a sample from well 3D at station 3 (125.5-135.5 feet) (Parks and others, 1993). The naphthalene concentration measured in the sample from well 3D at station 3 represents the deepest occurrence of a creosote contaminant in ground-water samples collected onsite. Naphthalene (classified both as a PAH and a VOC) may be used as a tracer of creosote contamination for the following reasons. Naphthalene is a primary PAH component of creosote (Goerlitz, 1992). Compared to other PAH's, naphthalene has greater aqueous solubility, and can partition from NAPL into ground water (Goerlitz and others, 1986; Pereira and Rostad, 1986). Also, naphthalene may show only limited sorption to aquifer material, especially in sediments having low organic content (Goerlitz and others, 1986). Therefore, naphthalene can travel with or beyond the extent of NAPL due to partitioning into ground water. However, naphthalene will biodegrade in certain aquifer environments, thus reducing its concentration in ground water (Chapelle, 1993).

The presence of phenolic compounds, specifically PCP, in onsite ground-water samples is significant because PCP is a priority pollutant and a contaminant commonly associated with wood-preserving processes (DaRos and others, 1981). PCP was detected in ground-water samples collected with the DPT Hydrocone tool from the alluvial aquifer at onsite stations 2 and 5 (Parks and others, 1993). PCP concentrations ranged from 120 to 3,200 $\mu\text{g/L}$ at station 5 with a maximum concentration in a sample from 20 to 21 feet below land surface. PCP concentrations ranged from 80 to 1,700 $\mu\text{g/L}$ at station 2 with the maximum concentration measured in a sample from 22 to 23 feet below land surface. PCP was not detected in any water sample from the Fort Pillow aquifer. Most PCP concentrations measured in ground-water samples from stations 2 and 5 exceed the primary MCL of 200 $\mu\text{g/L}$ for PCP (Tennessee Department of Environment and Conservation, 1993).

PCP is considered a tracer of creosote contamination in ground water. Studies suggest that PCP is not readily sorbed to aquifer material (Goerlitz and others, 1986), and seems to resist subsurface microbial degradation or inhibit microbial degradation of other phenols (Godsy and Goerlitz, 1986). Because PCP resists degradation in the subsurface environment, it may serve as a conservative tracer of creosote contamination (Goerlitz and others, 1986).

Concentrations of selected VOC's were measured using GC/PID headspace analysis in conjunction with the evaluation of subsurface exploration, sampling, and water-quality-analysis methods at onsite stations 2 and 5 (Parks and others, 1993). Considering all onsite water samples, maximum VOC concentrations were measured in water samples collected with the DPT Hydrocone tool from the alluvial aquifer at station 5 (20-21 feet), and downgradient station 2 (16-17 feet and 22-23 feet) (fig. 9).

Of the selected VOC analytes, BTEX compounds were detected at the highest concentrations, and these concentrations were measured in water samples from the alluvial aquifer at onsite stations 2 and 5 (fig. 9). Benzene concentrations exceeded the primary MCL of 5 $\mu\text{g/L}$ (Tennessee Department of Environment and Conservation, 1993) in seven of the nine ground-water samples from stations 2 and 5. Benzene concentrations in these samples ranged from 1 to 250 $\mu\text{g/L}$ (Parks and others,

1993). No BTEX compounds were detected at stations 2 and 5 below the ground-water DPT Hydrocone tool sample depth of 30 to 31 feet (Parks and others, 1993).

Other VOC's were detected in ground-water samples collected onsite (Parks and others, 1993). Trichloroethylene was detected in three ground-water samples collected with the DPT Hydrocone tool at onsite station 5, at concentrations of 23 $\mu\text{g/L}$ (23-24 feet), and 6 $\mu\text{g/L}$ (20-21 feet and 54-55 feet) (Parks and others, 1993). These trichloroethylene concentrations exceed the primary MCL of 5 $\mu\text{g/L}$ (Tennessee Department of Environment and Conservation, 1993). Methylene chloride was detected in a ground-water sample collected with the DPT Hydrocone tool from the alluvial aquifer at a concentration of 64 $\mu\text{g/L}$ at station 2 (22-23 feet), and in samples collected with the DPT Hydrocone tool and from a well screened in the Fort Pillow aquifer, at concentrations of 9 $\mu\text{g/L}$ at station 2 (64-65 feet) and 150 $\mu\text{g/L}$ in well 3D at station 3 (125.5-135.5 feet) (Parks and others, 1993). No primary MCL has been established for methylene chloride.

Dissolved trace elements were reported in some water samples collected from onsite wells for the RI/FS (S&ME, Inc., 1988). The trace elements most commonly detected were iron, barium, cadmium, chromium, copper, nickel, and lead. All trace element concentrations were below primary MCL's (Tennessee Department of Environment and Conservation, 1993) with the exception of cadmium (primary MCL 10 $\mu\text{g/L}$), which was detected at a concentration of 14 $\mu\text{g/L}$ in a water sample from well 1S at station 1 (20.5-25.5 feet).

Concentrations of total dissolved chromium indicate that this constituent may have reached greater depths beneath the site than organic compounds. Total dissolved chromium was measured in water samples from shallow, intermediate, and deep (less than 100 feet) wells at stations 1, 2, 3, and 5 (S&ME, Inc., 1988) (fig. 10). Total dissolved chromium concentrations in samples from deep wells ranged from 11 to 47 $\mu\text{g/L}$, similar to the range measured in samples from the shallow and intermediate wells (fig. 10). Concentrations of total dissolved chromium measured in water samples from onsite wells do not exceed the primary MCL of 50 $\mu\text{g/L}$ (Tennessee Department of Environment and Conservation, 1993).

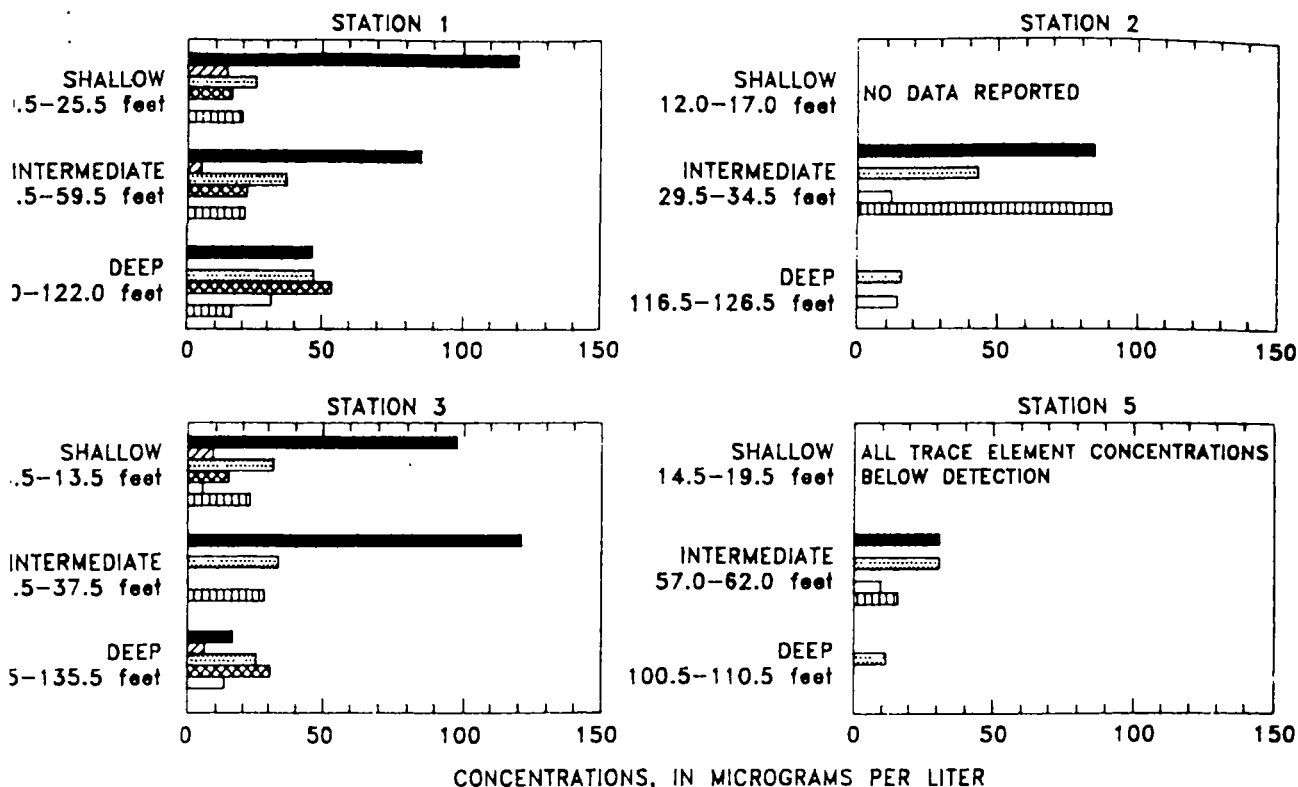
Chromated copper arsenate, fluor-chrome-arsenate phenol, chromated zinc chloride, and acid copper chromate are sometimes used in the wood-preserving processes (DaRos and others, 1981). However, the use of chromated compounds at the ACW facility has not been documented.

The distribution of dissolved arsenic in ground water beneath the site also may indicate ground-water contamination from the wood-preserving processes because arsenic was detected at a concentration of 22,000 $\mu\text{g/kg}$ from well 12 (14.5-19.5 feet) screened in the NAPL (S&ME, Inc., 1988). Dissolved arsenic was detected in water samples from two wells screened in the alluvial aquifer (S&ME, Inc., 1988) at concentrations of 12 $\mu\text{g/L}$ from well 11 (17.0-21.5 feet) and 31 $\mu\text{g/L}$ from well 18 (14.5-19.5 feet) (fig. 8). All dissolved arsenic concentrations reported for water samples from onsite wells are below the primary MCL of 50 $\mu\text{g/L}$ (Tennessee Division of Environment and Conservation, 1993).

High concentrations of dissolved iron were measured in some water samples from onsite wells (S&ME, Inc., 1988); however, the presence and distribution of dissolved iron cannot be related specifically to creosote contamination (Baedecker and Lindsay, 1986). Dissolved iron concentrations ranged between 1,800 $\mu\text{g/L}$ (well 1, 20.5-25.5 feet) to 2,400,000 $\mu\text{g/L}$ (well 18, 14.5-19.5 feet). High concentrations of dissolved iron in these water samples from wells screened in the alluvial aquifer may have resulted from microbial activity or reducing conditions that led to reduction of ferric (Fe^{3+}) iron precipitates to dissolved ferrous (Fe^{2+}) iron in ground water (Chapelle, 1993).

Offsite Water Quality

Thirty-six monitoring wells were installed at offsite stations OSGW1 through OSGW6 near the ACW site for this investigation (fig. 11; Appendix 2). At each station, well clusters were installed, each cluster consisting of 3 wells screened in the alluvial aquifer at depths of less than about 40 feet below land surface, and three wells screened in the Fort Pillow aquifer at depths ranging from about 45 to 150 feet (table 5).



EXPLANATION

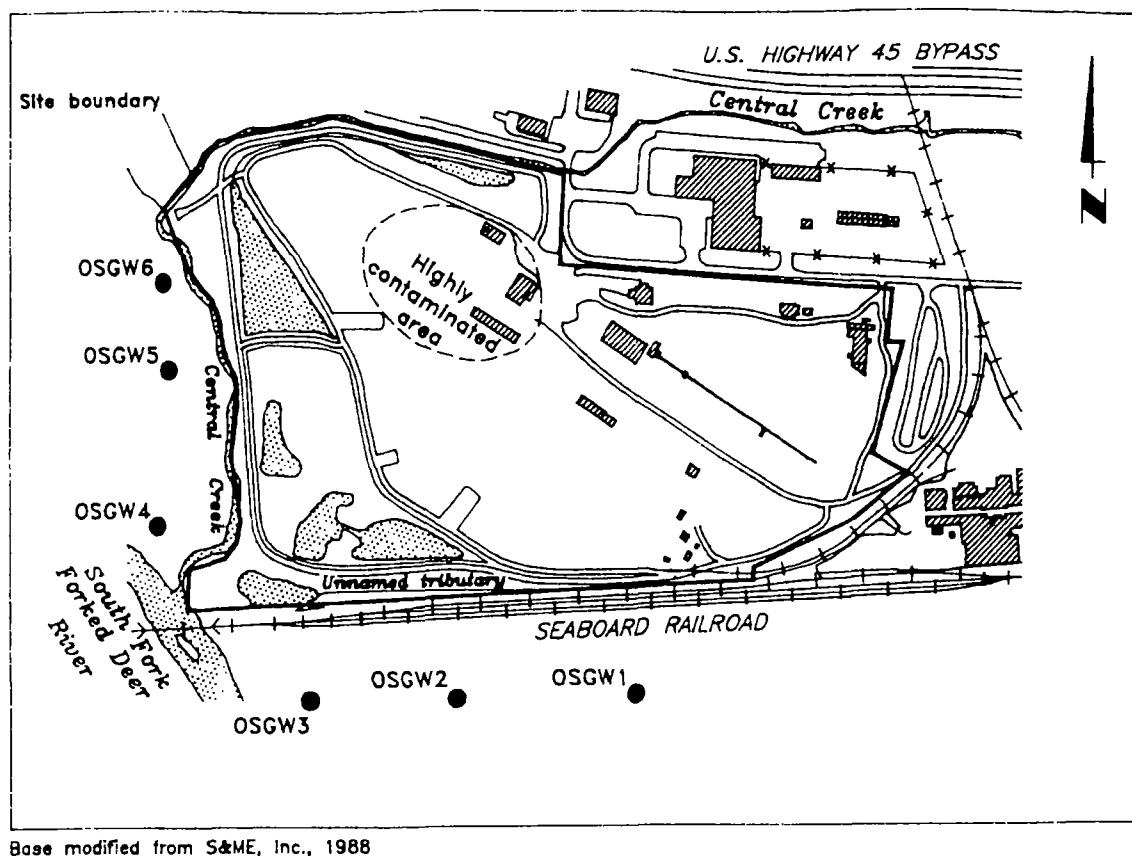
■ BARIUM	▤ COPPER
▨ CADMIUM	□ LEAD
▧ CHROMIUM	▩ NICKEL

re 10. Concentrations of selected trace elements measured in water samples from wells screened at shallow, intermediate, and deep depths at onsite stations 1, 2, 3, and 5 at the American Creosote Works abandoned plant

Ground-water samples were collected at the six onsite stations using two methods: (1) samples in the alluvial aquifer were collected using the Γ Hydrocone tool (July 29 to August 3, 1992) (2) by pumping shallow wells installed at each onsite station (October 22 to November 23, 1992). Hydrocone-tool sampling depths were selected at tops or bottoms of sand intervals, as interpreted in the logs of point-stress data measured with the Γ piezocone tool at each station (fig. 12). Comparison interpolations of lithology from the point-stress logs also were used as the primary guide to selection of screen intervals for shallow wells in the onsite clusters. Water samples from the Fort Pillow aquifer were collected only by pumping the deep wells installed at each offsite station

(October 29 to November 23, 1992). The DPT piezocone and Hydrocone tools could not penetrate into the Fort Pillow aquifer to collect lithologic information (Parks and others, 1993), so screen intervals for deep wells in offsite clusters were selected from interpretation of geophysical logs made in stratigraphic test holes at each station.

To determine the magnitude of offsite contamination, ground-water samples were analyzed for the same four groups of organic compounds that were detected in onsite ground-water samples--PAH's, phenolic compounds (including PCP), nitrogen-containing heterocyclic compounds, and VOC's. In addition, trace elements and major inorganic constituents, and water-quality characteristics were measured in offsite ground-water samples.



EXPLANATION

OSGW3 ● OFFSITE STATION AND NUMBER--
Six wells were installed and
sampled at each station

0 200 FEET
0 100 METERS

Figure 11. Location of offsite stations OSGW1 through OSGW6 where ground-water samples were collected with the Direct Push Technology Hydrocone tool.

Ground-water samples collected using the DPT Hydrocone tool were analyzed for PAH's, phenolic compounds (including PCP), and nitrogen-containing heterocyclic compounds by HPLC (table 6). The HPLC analyses were performed (August 10-11, 1992) by D.F. Goerlitz at the USGS National Research Program (NRP) laboratory in Menlo Park, California, following methods developed at a similar site at Pensacola, Florida (Goerlitz and Franks, 1989).

Only 3 of the 34 offsite ground-water samples collected by the DPT Hydrocone tool showed detectable levels of organic compounds related specifically to wood-preserving processes (D.F. Goerlitz, U.S. Geological Survey, written commun., 1992). Naphthalene was measured in a

ground-water sample from station OSGW6 (17-18 feet) at a concentration of 20 $\mu\text{g/L}$. Naphthalene also was measured in two ground-water samples from station OSGW6 (21-22 feet and 23-24 feet) at concentrations of 10 $\mu\text{g/L}$. All other ground-water samples were free of organic compounds normally found in ground water contaminated by creosote and PCP (D.F. Goerlitz, U.S. Geological Survey, written commun., 1992).

Splits of 34 offsite ground-water samples collected with the DPT Hydrocone tool were analyzed in the field by Environmental Management Corporation personnel by headspace analysis and GC/PID (July 29-August 3, 1992). Selected VOC's (table 7) from modified USEPA Methods 601, halo-carbons (U.S. Environmental Protection Agency,

Figure 5. Description of 36 wells installed at offsite stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant site

US, U.S. Geological Survey]

Well numbers				Altitude of		Screened		Installation	
Object	Local USGS	Latitude	Longitude,	above sea	Hydrogeologic	below land	Screen	Date	
and	for	in degree,	minutes,	level,	unit	surface,	diameter,	well	
map	Tennessee	and seconds		in feet	screened	in feet	in inches	installed	
								A - auger H - Hydraulic rotary	
SW1-1	Md:G-367	353628	0885005	343	Alluvial aquifer	13 - 18	2	08-18-92	A
SW1-2	Md:G-368	353628	0885005	343	Alluvial aquifer	19 - 24	2	08-18-92	A
SW1-3	Md:G-369	353628	0885005	343	Alluvium aquifer	27 - 32	2	08-19-92	A
SW1-4	Md:G-370	353628	0885005	343	Fort Pillow aquifer	42 - 52	4	06-25-92	H
SW1-5	Md:G-371	353628	0885005	343	Fort Pillow aquifer	92 - 102	4	06-30-92	H
SW1-6	Md:G-372	353628	0885005	343	Fort Pillow aquifer	128 - 138	4	06-30-92	H
SW2-1	Md:G-373	353627	0885011	342	Alluvial aquifer	10 - 15	2	08-20-92	A
SW2-2	Md:G-374	353627	0885011	342	Alluvial aquifer	17 - 22	2	08-20-92	A
SW2-3	Md:G-375	353627	0885011	342	Alluvial aquifer	24 - 29	2	08-20-92	A
SW2-4	Md:G-376	353627	0885011	342	Fort Pillow aquifer	62 - 72	4	06-02-92	H
SW2-5	Md:G-377	353627	0885011	342	Fort Pillow aquifer	92 - 102	4	06-04-92	H
SW2-6	Md:G-378	353627	0885011	342	Fort Pillow aquifer	127 - 137	4	06-09-92	H
SW3-1	Md:G-379	353627	0885016	341	Alluvial aquifer	9 - 14	2	08-24-92	A
SW3-2	Md:G-380	353627	0885016	341	Alluvial aquifer	15 - 20	2	08-24-92	A
SW3-3	Md:G-381	353627	0885016	341	Alluvial aquifer	24 - 29	2	08-24-92	A
SW3-4	Md:G-382	353627	0885016	341	Fort Pillow aquifer	36 - 46	4	06-23-92	H
SW3-5	Md:G-383	353627	0885016	341	Fort Pillow aquifer	68 - 78	4	06-24-92	H
SW3-6	Md:G-384	353627	0885016	341	Fort Pillow aquifer	138 - 148	4	08-06-92	H
SW4-1	Md:G-385	353632	0885021	343	Alluvial aquifer	10 - 15	2	08-27-92	A
SW4-2	Md:G-386	353632	0885021	343	Alluvial aquifer	22 - 27	2	08-27-92	A
SW4-3	Md:G-387	353632	0895021	343	Alluvial aquifer	36 - 41	2	08-27-92	A
SW4-4	Md:G-388	353632	0895021	343	Fort Pillow aquifer	48 - 58	4	07-29-92	H
SW4-5	Md:G-389	353632	0885021	343	Fort Pillow aquifer	79 - 89	4	07-30-92	H
SW4-6	Md:G-390	353632	0885021	343	Fort Pillow aquifer	117 - 127	4	08-04-92	H
SW5-1	Md:G-391	353637	0885022	342	Alluvial aquifer	12 - 17	2	08-26-92	A
SW5-2	Md:G-392	353637	0885022	342	Alluvial aquifer	19 - 24	2	08-26-92	A
SW5-3	Md:G-393	353637	0885022	342	Alluvial aquifer	27 - 32	2	08-26-92	A
SW5-4	Md:G-394	353637	0885022	342	Fort Pillow aquifer	40 - 50	4	07-14-92	H
SW5-5	Md:G-395	353637	0885022	342	Fort Pillow aquifer	83 - 93	4	07-14-92	H
SW5-6	Md:G-396	353637	0885022	342	Fort Pillow aquifer	113 - 123	4	07-28-92	H
SW6-1	Md:G-397	353639	0885023	342	Alluvial aquifer	10 - 15	2	08-25-92	A
SW6-2	Md:G-398	353639	0885023	342	Alluvial aquifer	19 - 24	2	08-25-92	A
SW6-3	Md:G-399	353639	0885023	342	Alluvial aquifer	27 - 32	2	08-25-92	A
SW6-4	Md:G-400	353639	0885023	342	Fort Pillow aquifer	50 - 60	4	07-07-92	H
SW6-5	Md:G-401	353639	0885023	342	Fort Pillow aquifer	82 - 92	4	07-08-92	H
SW6-6	Md:G-402	353639	0885023	342	Fort Pillow aquifer	120 - 130	4	07-08-92	H

POINT STRESS, IN KILOGRAMS PER SQUARE CENTIMETER

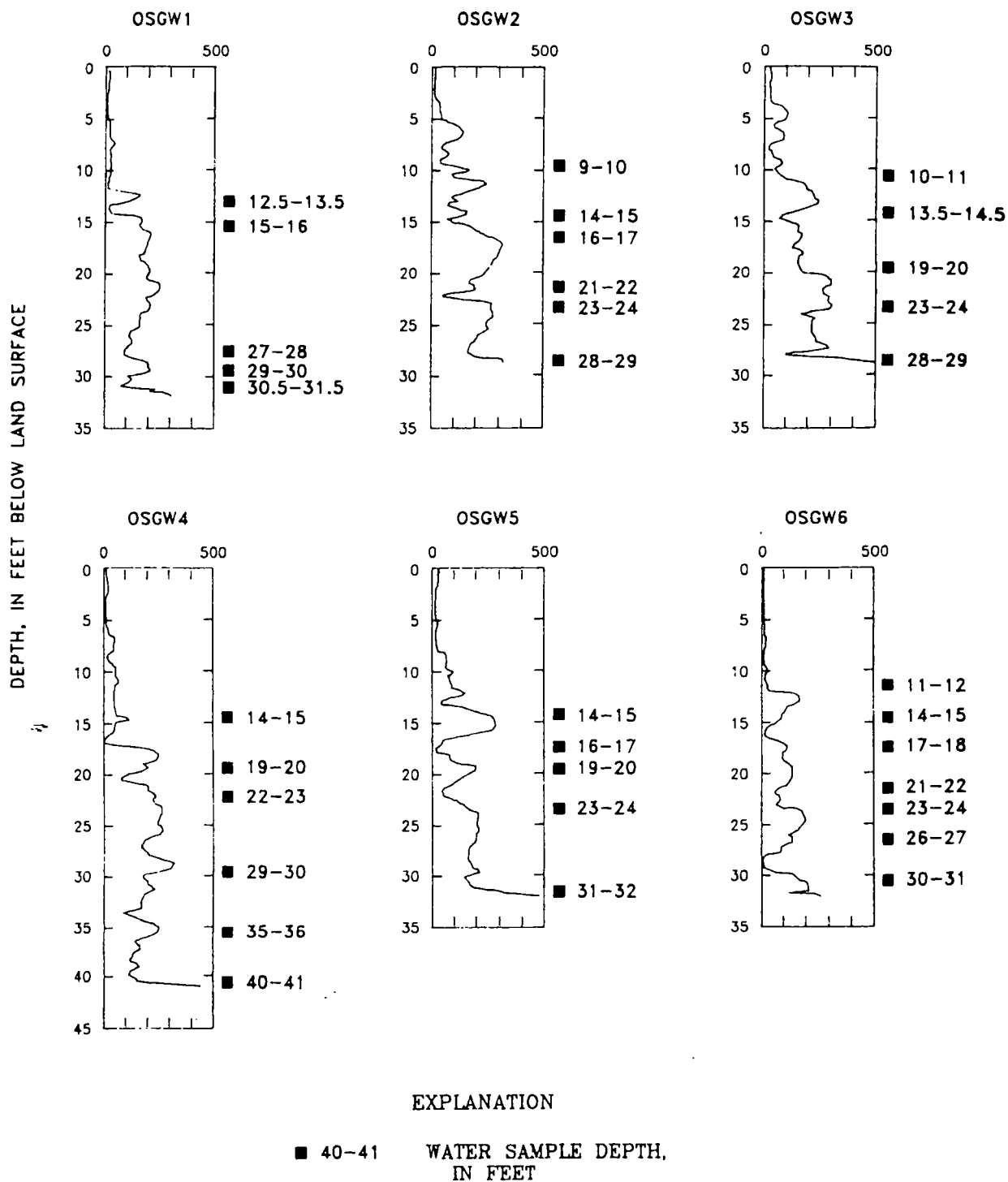


Figure 12. Logs of point-stress data measured with the Direct Push Technology piezocone tool and depths of ground-water samples collected with the Hydrocone tool at offsite stations OSGW1 through OSGW6 at the American Creosote Works abandoned plant site.

Table 6. Polynuclear aromatic hydrocarbons, phenolic compounds (including pentachlorophenol), and nitrogen-containing heterocyclic compounds analyzed in ground-water samples collected with the Direct Push Technology Hydrocone tool at offsite stations OSGW1 through OSGW6 near the American Creosote abandoned plant

Minimum detection limit, in micrograms per liter, in parentheses

nuclear aromatic hydrocarbons	Nitrogen-containing heterocyclic compounds
anthracene (1)	Isoquinoline (2)
fluorene (1)	Isoquinolinone (2)
phenanthrene (1)	Quinoline (2)
Dihydroacenaphthalene (1)	Quinolinone (2)
ethylanthracene (1)	2-Methylquinoline (5)
Phenolic compounds	
Dimethylphenol (5)	3,5-Dimethylphenol (5)
Dimethylphenol (5)	2-Methylphenol (5)
Dimethylphenol (5)	3-Methylphenol (5)
Dimethylphenol (5)	Pentachlorophenol (5)
Dimethylphenol (5)	Phenol (5)

Table 7. Volatile organic compounds analyzed in ground-water samples collected with the Direct Push Technology Hydrocone tool at offsite stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant site

Minimum detection limit 1 microgram per liter

benzene	Toluene
monobenzene	m-Xylene
diobenzene	o-Xylene
methyl-tert-butyl ether	

Minimum detection limit 5 micrograms per liter

perchloroform	1,1,2,2-Tetrachloroethane
chloroethyl vinyl ether	Tetrachloroethylene
1,1,2-Dichloroethylene	1,1,1-Trichloroethane
Dichloroethane	1,1,2-Trichloroethane
Dichloroethane	Trichloroethylene
Dichloropropane	Vinyl chloride
methylene chloride	

4a), and 602, aromatics (U.S. Environmental Protection Agency, 1984b) are reported here. For comparison, VOC's measured in ground-water

samples using GC/PID from onsite stations 2 and 5 were: BTEX's, methyl-tert-butyl ether, 1,1-dichloroethane, methylene chloride, and trichloroethylene (Parks and others, 1993).

BTEX compounds, except benzene, were the most common VOC's measured in offsite water samples collected from the alluvial aquifer with the DPT Hydrocone tool (table 8). The most common BTEX compound was xylene (including both m-xylene and o-xylene), which was detected in some ground-water samples from all offsite stations. Xylene concentrations ranged between 2 µg/L (many samples; table 8) and 790 µg/L (one sample; station OSGW6, 11-12 feet). For comparison, xylene concentrations in ground-water samples from onsite stations 2 and 5 ranged between 9 and 1,300 µg/L in alluvial aquifer samples collected above 35 feet (Parks and others, 1993). Where detected, concentrations of ethylbenzene ranged between 2 and 10 µg/L (table 8). For comparison, ethylbenzene concentrations in ground-water samples from onsite stations 2 and 5 ranged between 2 and 1,900 µg/L in alluvial aquifer samples collected above 35 feet (Parks and others, 1993).

Benzene was measured in onsite ground-water samples from stations 5 and 2 at concentrations exceeding the primary MCL of 5 µg/L (Tennessee Department of Environment and Conservation, 1993), but was not detected in any offsite ground-water sample collected with the DPT Hydrocone tool. Toluene was detected only in offsite ground-water samples from station OSGW6, at concentrations ranging between 2 and 5 µg/L (table 8).

VOC's and SVC's also were measured in offsite water samples collected from the alluvial aquifer and Fort Pillow aquifers by pumping the 36 wells at stations OSGW1 through OSGW6 (Appendix 1). These samples were analyzed for a selected list of VOC's and SVC's (table 9), by the USGS National Water Quality Laboratory (NWQL). VOC concentrations in water samples pumped from wells at offsite stations OSGW1 through OSGW6 are discussed here; SVC concentrations from these same samples are discussed later in the text.

BTEX compounds were the principal VOC's detected in samples pumped from offsite wells screened in the alluvial aquifer, and analyzed by the NWQL. Where detected, BTEX sum concentrations ranged between 0.2 and 4.6 µg/L, with highest BTEX sum concentrations reported for water

Table 8. Concentrations of volatile organic compounds detected in ground-water samples collected with the Direct Push Technology Hydrocone tool at offsite stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant site, July-August 1992

[Analyses conducted by Environmental Management Corp., Orlando, Florida, using a Photovac 10S50 gas chromatograph with photo-ionization detection (GC/PID). Concentrations are in micrograms per liter ($\mu\text{g/L}$); (TDEC) Tennessee Department of Environment and Conservation, 1993, (MCL) primary maximum contaminant levels for drinking water; "none" indicates no established maximum contaminant level for the compound]

Volatile organic compound	Analytical method minimum detection limit ($\mu\text{g/L}$)	Offsite station number	Depth of Hydrocone sample (feet)	Concentration detected ($\mu\text{g/L}$)	TDEC MCL ($\mu\text{g/L}$)
Ethylbenzene	1	OSGW1	27 - 28	2	none
		OSGW1	30.5 - 31.5	2	
		OSGW2	21 - 22	2	
		OSGW4	14 - 15	10	
		OSGW4	40 - 41	3	
		OSGW5	19 - 20	2	
		OSGW6	17 - 18	6	
		OSGW6	26 - 27	7	
Toluene	1	OSGW6	11 - 12	2	none
		OSGW6	14 - 15	3	
		OSGW6	26 - 27	5	
m-Xylene	1	OSGW1	29 - 30	4	none
		OSGW3	13.5 - 14.5	3	
		OSGW4	14 - 15	3	
		OSGW4	22 - 23	3	
		OSGW5	16 - 17	3	
		OSGW5	31 - 32	9	
		OSGW6	11 - 12	790	
		OSGW6	23 - 24	2	
		OSGW6	26 - 27	10	
		OSGW6	30 - 31	14	
o-Xylene	1	OSGW1	27 - 28	28	none
		OSGW1	29 - 30	3	
		OSGW2	14 - 15	2	
		OSGW2	21 - 22	2	
		OSGW2	23 - 24	2	
		OSGW3	10 - 11	2	
		OSGW4	29 - 30	2	
		OSGW4	35 - 36	12	
		OSGW5	16 - 17	5	
		OSGW5	19 - 20	3	
		OSGW5	31 - 32	15	
		OSGW6	17 - 18	2	
		OSGW6	23 - 24	2	
		OSGW6	26 - 27	15	

ile 9. Volatile and semi-volatile organic compounds analyzed in water samples collected by pumping 36 wells at site stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant site

Volatile organic compounds

imum detection limit, in micrograms per liter, in parentheses]

olein (20)	1,2-Dichlorobenzene (ortho) (0.2)	Methylene chloride (0.2)
ylonitrile (20)	1,3-Dichlorobenzene (meta) (0.2)	Methyl-tert-butyl ether (1)
zene (0.2)	1,4-Dichlorobenzene (para) (0.2)	Naphthalene (0.2)
mobenzene (0.2)	Dibromochloromethane (0.2)	n-Propylbenzene (0.2)
mochloromethane (0.2)	Dichlorodifluoromethane (0.2)	Styrene (0.2)
moform (0.2)	1,1-Dichloroethane (0.2)	1,1,1,2-Tetrachloroethane (0.2)
tylbenzene (0.2)	1,2-Dichloroethane (0.2)	1,1,2,2-Tetrachloroethane (0.2)
Butylbenzene (0.2)	cis-1,2-Dichloroethene (0.2)	Tetrachloroethylene (0.2)
Butylbenzene (0.2)	1,1-Dichloroethene (0.2)	Toluene (0.2)
on tetrachloride (0.2)	trans-1,2-Dichloroethylene (0.2)	1,2,3-Trichlorobenzene (0.2)
robenzene (0.2)	1,2-Dichloropropane (0.2)	1,2,4-Trichlorobenzene (0.2)
rodibromomethane (0.2)	1,3-Dichloropropane (0.2)	1,1,1-Trichloroethane (0.2)
roethane (0.2)	2,2-Dichloropropane (0.2)	1,1,2-Trichloroethane (0.2)
loroethyl vinyl ether (1.0)	1,1-Dichloropropene (0.2)	Trichloroethylene (0.2)
roform (0.2)	cis-1,3-Dichloropropene (0.2)	Trichlorofluoromethane (0.2)
romethane (0.2)	trans-1,3-Dichloropropene (0.2)	Trichlorotrifluoroethane (0.5)
lorotoluene (0.2)	Ethylbenzene (0.2)	1,2,3-Trichloropropane (0.2)
lorotoluene (0.2)	Hexachlorobutadiene (0.2)	1,2,4-Trimethylbenzene (0.2)
Dibromo-3-chloropropane (1.0)	Isopropylbenzene (0.2)	1,3,5-Trimethylbenzene (0.2)
omomethane (0.2)	p-Isopropyltoluene (0.2)	Vinyl chloride (0.2)
Dibromoethane (0.2)	Methylbromide (0.2)	Xylenes (total) (0.2)

Semi-volatile organic compounds

imum detection limit, in micrograms per liter, in parentheses]

naphthene (5)	Dibenzo(a,h)anthracene (10)	Hexachlorobenzene (5)
naphthylene (5)	Di-n-butyl phthalate (5)	Hexachlorobutadiene (5)
racene (5)	1,2-Dichlorobenzene (5)	Hexachlorocyclopentadiene (5)
zidine (40)	1,3-Dichlorobenzene (5)	Hexachloroethane (5)
Benzo(a)anthracene (10)	1,4-Dichlorobenzene (5)	Indeno (1,2,3) pyrene (10)
zo(b)fluoranthene (10)	3,3-Dichlorobenzidene (20)	Isophorone (5)
zo(k)fluoranthene (10)	2,4-Dichlorophenol (5)	Naphthalene (5)
Benzo(g,h,i)perylene (10)	Diethyl phthalate (5)	Nitrobenzene (5)
zo(a)pyrene (10)	2,4-Dimethylphenol (5)	2-Nitrophenol (5)
omophenyl phenyl ether (5)	Dimethyl phthalate (5)	4-Nitrophenol (30)
1 benzyl phthalate (5)	4,6-Dinitro-2-methylphenol (30)	n-Nitrosodimethylamine (5)
2-Chloroethyl)ether (5)	2,4-Dinitrophenol (20)	n-Nitrosodiphenylamine (5)
2-Chloroethyl)methane (5)	2,4-Dinitrotoluene (5)	n-Nitroso-di-n-propylamine (5)
2-Chloroisopropyl)ether (5)	2,6-Dinitrotoluene (5)	Pentachlorophenol (30)
loro-3-methylphenol (30)	Di-n-octyl phthalate (10)	Phenanthrene (5)
loronaphthalene (5)	1,2-Diphenylhydrazine (5)	Phenol (5)
lorophenol (5)	bis(2-Ethylhexyl)phthalate (5)	Pyrene (5)
lorophenyl phenyl ether (5)	Fluoranthene (5)	1,2,4-Trichlorobenzene (5)
sene (10)	Fluorene (5)	2,4,6-Trichlorophenol (20)

samples from well OSGW6-1 (table 10). Benzene was measured at concentrations ranging between 0.2 and 0.4 $\mu\text{g/L}$ where detected in water samples from the alluvial aquifer. Toluene was detected in ground-water samples collected offsite, but these low concentrations may be the result of a quality assurance/quality control (QA/QC) problem (Appendix 1). Water samples from 8 of the 24 wells suspected as being affected by a QA/QC problem were resampled in January 1993 and analyzed for VOC's. Neglecting the analyses that might have been affected by a QA/QC problem, toluene was detected in samples from three wells (OSGW4-1, OSGW4-5, and OSGW6-2) at concentrations of 0.2 to 0.3 $\mu\text{g/L}$ (table 10, second sample). Ethylbenzene was detected in two ground-water samples at concentrations of 0.2 $\mu\text{g/L}$ (OSGW6-1) and 0.3 $\mu\text{g/L}$ (OSGW6-3). Xylene concentrations ranged between <0.2 and 1.6 $\mu\text{g/L}$ where detected. Highest xylene concentrations were measured in water samples from wells OSGW6-1, OSGW6-2, and OSGW6-3 (table 10).

BTEX concentrations measured in water samples collected with the DPT Hydrocone tool from the alluvial aquifer generally are 10 times greater than BTEX concentrations measured in water samples pumped from wells screened in this aquifer. One reason for this disparity is that the interval sampled by DPT was 1 foot, while the screened interval for wells in alluvial aquifer was 5 feet. VOC concentrations may be diluted in samples from pumped offsite wells because of the greater vertical interval sampled, and the heterogeneous distribution of contaminants in the aquifer. Although precautions against VOC loss were performed and the ground-water samples were chilled before express transport (Appendix 1), it is possible that VOC concentrations could diminish by volatilization during sample collection and transport.

Individual BTEX compounds in water samples collected from the alluvial aquifer with the DPT Hydrocone tool were measured at concentrations commonly ranging between 2 and 28 $\mu\text{g/L}$ (table 8). Individual BTEX compounds in water samples collected from the 18 wells screened in the alluvial aquifer were measured at concentrations less than 2.1 $\mu\text{g/L}$ (table 10). Considering the spatial distribution of BTEX compounds, at least one BTEX compound was detected in water sam-

ples collected with the DPT Hydrocone tool at each offsite station (table 8). In contrast, BTEX compounds were not detected in water samples collected from wells at stations OSGW1, OSGW2, and OSGW3 (table 10). Therefore, a greater number of BTEX compounds were detected at higher concentrations in offsite water samples from the alluvial aquifer collected with the DPT Hydrocone tool. However, results from both sample collection methods indicate that BTEX compounds (primarily xylenes) were detected in water samples from the alluvial aquifer at depths less than about 35 feet, with highest BTEX concentrations measured in water samples from offsite stations OSGW5 and OSGW6 (table 10).

Minor differences between the first and second sample concentrations of benzene and xylene are reported for water samples from wells at stations OSGW5 and OSGW6 (table 10). Benzene and xylene concentrations were usually (but not always) lower in the second water sample, by 0.7 $\mu\text{g/L}$ or less. These differences in concentrations between the first and second samples may be the result of the 2-month period between sample collection, or different lengths of time the wells were purged before sampling. Benzene and xylene were not detected in blanks, so these differences are not attributed to a QA/QC problem.

BTEX concentrations are significantly lower in ground-water samples collected from offsite stations than those collected onsite, regardless of the sample collection method used. In water samples collected with the DPT Hydrocone tool in the alluvial aquifer at onsite stations 2 and 5, ethylbenzene was detected at the highest concentrations, ranging between 2 and 1,900 $\mu\text{g/L}$ (fig. 9). Similar ranges in benzene, toluene, and xylene concentrations also were measured in these samples (Parks and others, 1993).

Considering ground-water samples from all offsite stations, xylene was the BTEX compound detected at the highest concentrations. Xylene concentrations ranged between 0.2 and 790 $\mu\text{g/L}$ in water samples collected with the DPT Hydrocone tool (table 8); and ranged between <0.2 and 0.3 $\mu\text{g/L}$ in pumped water samples (table 10). Where detected, ethylbenzene and toluene ranged between 2 and 10 $\mu\text{g/L}$ in water samples collected with the DPT Hydrocone tool (table 8); and <0.2 and 0.3 $\mu\text{g/L}$ in pumped water samples (table 10).

Table 10. Concentrations of volatile and semi-volatile organic compounds detected in water samples collected by sampling 36 wells at offsite stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant October 1992-January 1993

Concentrations are in micrograms per liter ($\mu\text{g/L}$); (TDEC) Tennessee Department of Environment and Conservation, 1993, (MCL) primary maximum contaminant level for drinking water; values given as < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a compound; "none" indicates no established maximum contaminant level for compound; -- indicates no second sample collected

Synthetic organic compound	Analytical method minimum detection limit	Wells in which detected	Concentration detected		TDEC MCL
			First sample	Second sample	
Volatile organic compounds					
benzene	.02	OSGW4-3 (Md:G-387)	0.4	--	5
		OSGW5-3 (Md:G-393)	.2	< 0.2	
		OSGW6-1 (Md:G-397)	.4	--	
		OSGW6-3 (Md:G-399)	.4	--	
		OSGW6-5 (Md:G-401)	.2	--	
		OSGW6-6 (Md:G-402)	.2	< .2	
monochloromethane	.2	OSGW5-4 (Md:G-394)	.2	--	none
orthoform	.2	OSGW5-4 (Md:G-394)	.4	--	none
paraform	.2	OSGW1-5 (Md:G-371)	.2	--	none
		OSGW5-4 (Md:G-394)	.2	--	
monochloromethane	.2	OSGW5-4 (Md:G-394)	.7	--	none
monochlorobenzene	.2	OSGW2-1 (Md:G-373)	.6	--	none
1,2-Dichloroethylene	.2	OSGW6-1 (Md:G-397)	.2	--	none
benzene	.2	OSGW6-1 (Md:G-397)	.2	--	none
		OSGW6-3 (Md:G-399)	.3	--	
ethylene	.2	OSGW4-1 (Md:G-385)	.6	--	none
		OSGW4-2 (Md:G-386)	3.0	--	
benzene	.2	OSGW4-1 (Md:G-385)	.2	--	none
		OSGW4-5 (Md:G-389)	.2	--	
		OSGW6-2 (Md:G-398)	2.1	3	

Table 10. Concentrations of volatile and semi-volatile organic compounds detected in water samples collected by pumping 36 wells at offsite stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant site, October 1992-January 1993--Continued

Synthetic organic compound	Analytical method minimum detection limit	Wells in which detected	Concentration detected		TDEC MCL
			First sample	Second sample	
Volatile organic compounds—Continued					
Trichloroethylene	.2	OSGW6-1 (Md:G-397)	1.6	—	5
		OSGW6-2 (Md:G-398)	.90	.2	
		OSGW6-3 (Md:G-399)	.20	—	
1,2,4-Trimethylbenzene	.2	OSGW6-1 (Md:G-397)	.3	--	none
		OSGW6-2 (Md:G-398)	< .2	.2	
		OSGW6-3 (Md:G-399)	.4	--	
		OSGW6-5 (Md:G-401)	.2	—	
		OSGW6-6 (Md:G-402)	.2	< .2	
Total Xylenes	.2	OSGW4-6 (Md:G-390)	.7	—	none
		OSGW5-5 (Md:G-395)	.2	—	
		OSGW6-1 (Md:G-397)	1.0	—	
		OSGW6-2 (Md:G-398)	< .2	.4	
		OSGW6-3 (Md:G-399)	1.6	—	
		OSGW6-5 (Md:G-401)	.9	—	
		OSGW6-6 (Md:G-402)	.7	< .2	
Semi-volatile organic compounds					
bis(2-Ethylhexyl)phthalate	5	OSGW1-5 (Md:G-371)	9	—	6
		OSGW1-6 (Md:G-372)	27	--	
		OSGW2-5 (Md:G-377)	9	—	
		OSGW3-6 (Md:G-384)	25	—	
		OSGW4-6 (Md:G-390)	8	--	
		OSGW5-4 (Md:G-394)	15	--	
		OSGW6-5 (Md:G-401)	13	—	
Butyl benzyl phthalate		OSGW6-2 (Md:G-398)	9	—	

benzene was not detected in any offsite water samples collected with the DPT Hydrocone tool (table 8); however, benzene concentrations ranged between <0.2 and $0.4 \mu\text{g/L}$ in the first samples from pumped wells screened in the alluvial aquifer (table 10).

A conservative estimate shows that BTEX concentrations in water samples from the alluvial aquifer have been reduced significantly. Xylene concentrations have been reduced by at least 50 percent; this compound has migrated with ground water toward the offsite stations.

BTEX compounds were not detected in any water sample collected from the Fort Pillow aquifer on-site stations 2 and 5 (Parks and others, 1993). BTEX compounds were detected in water samples from several of the 18 wells screened in the Fort Pillow aquifer at the offsite stations. These water samples were collected from pumped wells, because the DPT Hydrocone tool could not penetrate into the Fort Pillow aquifer. Benzene was measured in samples from wells OSGW6-5 (82-92 feet) and OSGW6-6 (120-130 feet) at a concentration of $1 \mu\text{g/L}$ (table 10). Xylenes also were measured in these samples at concentrations of 0.9 and $1 \mu\text{g/L}$, respectively (table 10).

Trihalomethanes (bromodichloromethane, bromochloromethane, bromoform, and chloroform) were detected in one water sample from well OSGW5-4 (40-50 feet) pumped from the Fort Pillow aquifer at concentrations ranging between 0.2 and $0.7 \mu\text{g/L}$ (table 10). The presence of trihalomethanes in a water sample from the Fort Pillow aquifer is problematic because trihalomethanes are by-products of the wood-preserving processes, but no trihalomethanes were detected in water samples from on-site wells. The sum of trihalomethane concentrations (including bromoform, chloroform, bromodichloromethane, dibromochloromethane) in a sample from well OSGW5-4 is $1.5 \mu\text{g/L}$, which is now the primary MCL of $100 \mu\text{g/L}$ for this class of compounds (U.S. Environmental Protection Agency, 1992).

SVC's in water samples collected offsite from 36 wells at the six stations were analyzed by the NWQL (table 9). The list of analytes includes H's and phenolic compounds including PCP that characterize creosote contamination. However, this does not contain many of the phenolic and oxygen-containing heterocyclic compounds ana-

lyzed by HPLC (Parks and others, 1993) (table 6). Some HPLC analytes (such as substituted naphthalenes, methyl phenols, and quinoline) are alteration products specific to creosote contamination (Goerlitz and others, 1985); however, these compounds are not routine SVC analytes by the NWQL (table 9).

SVC's, PAH's, phenolic compounds, and phthalic acid esters that were detected on-site in ground-water samples at stations 2 and 5 (Parks and others, 1993) or from shallow monitoring wells (S&ME, Inc., 1988) were: acenaphthene, acenaphthylene, anthracene, 1,2-benzo(a)anthracene, benzo(b and/or k)fluoranthene, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, fluorene, naphthalene, PCP, phenanthrene, phenol, 2,4-dimethylphenol, and pyrene. SVC's analyzed for (but not necessarily detected; S&ME, Inc., 1988) in on-site ground-water samples, but not included on the NWQL list of analytes were: biphenyl, dibenzofuran, dibenzothionate, substituted naphthalenes (1-methylnaphthalene, 2-methylnaphthalene, dimethylnaphthalene, trimethylnaphthalene, phenylnaphthalene), methylphenanthrene, methylpyrene, and naphthenecarbonitrile.

PAH's represent 85 percent of the compounds in creosote by weight (Goerlitz and others, 1985). As a group, these compounds show slight aqueous solubility, and tend to partition to non-aqueous phases. Of the PAH's considered here, naphthalene has the highest aqueous solubility at a concentration of 30 milligrams per liter (mg/L) (Goerlitz, 1992), compared to anthracene and phenanthrene, which have a greater molecular weight and lower aqueous solubility. Despite the common presence of PAH's in on-site ground-water samples, no PAH's were detected in water samples from wells at the offsite stations when analyzed for SVC's (table 10). However, when ground-water samples were analyzed for naphthalene as a VOC by the NWQL, it was detected in samples from offsite wells OSGW4-1 (10-15 feet) and OSGW4-2 (22-27 feet), screened in the alluvial aquifer, at concentrations of 0.6 and $3.0 \mu\text{g/L}$, respectively (table 10).

Several environmental factors probably contributed to the attenuation of PAH concentrations as ground water migrated from on-site to offsite areas. These factors are microbial degradation (Goerlitz and others, 1985; Madsen and others, 1991), and sorption onto clay-mineral surfaces.

Phenolic compounds as a group show greater aqueous solubility than PAH's, with the exception of PCP. The aqueous solubility of dimethyl phenols (4,000 mg/L) and phenols (80,000 mg/L; Goerlitz, 1992) suggests that these compounds may partition from the NAPL into ground water. In contrast, experimental calculations suggest that PCP has an aqueous solubility of 5 to 10 mg/L at a pH range of 5 to 6 (Goerlitz and others, 1985), similar to the pH range measured in offsite ground-water samples. Compared to other phenols, PCP would tend to remain in the NAPL.

Phenols and methylphenols were shown to be degraded by microbes at the Pensacola, Florida ACW abandoned plant site (Goerlitz and others, 1986; Goerlitz, 1992). Dimethylphenols and PCP resist or possibly inhibit biodegradation (Chapelle, 1993). Of all phenolic compounds analyzed for (table 6), dimethylphenols (for example 2,4-dimethylphenol and 3,5-dimethylphenol) would be expected to travel with ground water because of their relatively high aqueous solubilities and resistance to biodegradation. However, no dimethylphenols or PCP were detected in water samples from wells at the offsite stations.

Nitrogen-containing heterocyclic compounds such as quinoline represent approximately 5 percent of the compounds in creosote by weight (Goerlitz and others, 1985). These compounds are readily altered in both aerobic and anaerobic conditions. Consequently, nitrogen-containing heterocyclic compounds commonly are not detected in ground-water samples except by immediate analysis or in samples preserved with mercuric chloride bactericide (Godsy and Goerlitz, 1986; Goerlitz, 1992). No nitrogen-containing heterocyclic compounds were detected in water samples from wells at offsite stations (D.F. Goerlitz, U.S. Geological Survey, written commun., 1992), which were preserved with mercuric chloride and analyzed immediately on receipt at the NRP laboratory.

Two other SVC's were detected in offsite ground-water samples: bis(2-ethylhexyl)phthalate and butyl benzyl phthalate. Both compounds are used as plasticizers in PVC resins, with bis(2-ethylhexyl)phthalate used most commonly (U.S. Environmental Protection Agency, 1990). Bis(2-ethylhexyl)phthalate was measured in some water samples from offsite wells screened in the Fort Pillow aquifer, at concentrations ranging between 8

and 27 $\mu\text{g/L}$ (table 10). These plasticizers are not associated specifically with wood-preserving processes, and are considered ubiquitous in the environment (U.S. Environmental Protection Agency, 1990). Currently, MCL's have not been established for phthalates, although a MCL of 100 $\mu\text{g/L}$ has been proposed for butyl benzyl phthalate (U.S. Environmental Protection Agency, 1990). All phthalate concentrations measured in offsite ground-water samples were below this proposed MCL.

Dissolved trace elements were measured in samples from the 36 wells at the offsite stations (table 11). Barium, cobalt, iron, manganese, nickel, strontium, and zinc commonly were detected; however, concentrations of these trace elements were below established primary MCL's (Tennessee Division of Environment and Conservation, 1993) in all water samples from offsite wells. For comparison, the dissolved trace elements that commonly were detected in onsite ground-water samples were barium, cadmium, chromium, copper, iron, lead, and nickel (S&ME, Inc., 1988).

Maximum dissolved iron concentrations were measured in water samples from offsite wells screened in the alluvial aquifer, specifically in samples from depths of 10 to 18 feet (table 11). Iron concentrations in these samples ranged between 70 and 20,000 $\mu\text{g/L}$, with the highest concentration measured in a water sample from well OSGW6-1 at a depth of 10 to 15 feet (table 11). These high iron concentrations cannot be related specifically to contamination from wood-preserving processes, although ferrous (Fe^{2+}) iron may exist in solution due to reducing conditions or a result of microbial activity in the alluvial aquifer (Chapelle, 1993).

Dissolved chromium was measured at concentrations ranging from 11 to 47 $\mu\text{g/L}$ in onsite water samples from the alluvial and Fort Pillow aquifers (S&ME, 1988) (fig. 10). By comparison, chromium was measured in some water samples from offsite wells screened in both the alluvial and Fort Pillow aquifers, but at concentrations of 1 to 2 $\mu\text{g/L}$ (table 11). All chromium concentrations measured in offsite ground-water samples were below the primary MCL of 50 $\mu\text{g/L}$ (Tennessee Department of Environment and Conservation, 1993).

Dissolved barium commonly was detected in offsite water samples from the alluvial aquifer and

near the American Creosote Works abandoned plant site

[USGS, U.S. Geological Survey; $\mu\text{g/L}$, micrograms per liter. Values gives as < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent; —, indicates no data]

Project and map (fig. 11)	Well numbers USGS local for Tennessee	Screened interval below land surface, in feet	Date sampled	Aluminum, dissolved ($\mu\text{g/L}$ as Al)	Arsenic, dissolved ($\mu\text{g/L}$ as As)	Barium, dissolved ($\mu\text{g/L}$ as Ba)	Beryllium, dissolved ($\mu\text{g/L}$ as Be)	Cadmium, dissolved ($\mu\text{g/L}$ as Cd)	Chromium, dissolved ($\mu\text{g/L}$ as Cr)	Cobalt, dissolved ($\mu\text{g/L}$ as Co)
OSGW1-1	Md:G-367	13 - 18	10-22-92	<10	<1	77	<0.5	<1	<1	4
OSGW1-2	Md:G-368	19 - 24	10-22-92	<10	<1	61	<.5	<1	1	<3
OSGW1-3	Md:G-369	27 - 32	10-22-92	<10	<1	48	<.5	1	<1	<3
OSGW1-4	Md:G-370	42 - 52	11-04-92	<10	<1	53	<.5	<1	<1	<3
OSGW1-5	Md:G-371	92 - 102	11-04-92	<10	<1	32	.6	<1	<1	<3
OSGW1-6	Md:G-372	128 - 138	11-04-92	<10	<1	34	.7	<1	<1	<3
OSGW2-1	Md:G-373	10 - 15	10-22-92	<10	<1	99	<.5	1	<1	14
OSGW2-2	Md:G-374	17 - 22	10-23-92	<10	<1	70	<.5	<1	<1	<3
OSGW2-3	Md:G-375	24 - 29	10-23-92	<10	<1	57	<.5	<1	<1	<3
OSGW2-4	Md:G-376	62 - 72	11-06-92	<10	<1	74	.7	<1	<1	<3
OSGW2-5	Md:G-377	92 - 102	11-06-92	<10	<1	44	.7	<1	<1	<3
OSGW2-6	Md:G-378	127 - 137	11-05-92	<10	<1	32	.7	<1	<1	<3
OSGW3-1	Md:G-379	9 - 14	10-28-92	20	<1	89	<.5	<1	<1	8
OSGW3-2	Md:G-380	15 - 20	10-28-92	20	<1	60	<.5	<1	2	<3
OSGW3-3	Md:G-381	24 - 29	10-30-92	<10	<1	44	<.5	<1	<1	<3
OSGW3-4	Md:G-382	36 - 46	10-29-92	<10	<1	47	<.5	<1	2	<3
OSGW3-5	Md:G-383	68 - 78	10-29-92	<10	<1	52	<.5	<1	<1	<3
OSGW3-6	Md:G-384	138 - 148	11-03-92	—	<1	25	.7	<1	2	<3
OSGW4-1	Md:G-385	10 - 15	11-20-92	10	<1	47	<.5	<1	<1	6
OSGW4-2	Md:G-386	22 - 27	11-20-92	<10	<1	41	<.5	<1	<1	<3
OSGW4-3	Md:G-387	36 - 41	11-20-92	40	<1	14	<.5	1	<1	<3
OSGW4-4	Md:G-388	48 - 58	11-20-92	10	<1	27	<.5	<1	2	<3
OSGW4-5	Md:G-389	78 - 89	11-23-92	<10	<1	20	<.5	2	<1	<3
OSGW4-6	Md:G-390	117 - 127	11-20-92	<10	<1	9	<.5	<1	<1	<3
OSGW5-1	Md:G-391	12 - 17	11-19-92	<10	1	180	<.5	2	<1	37
OSGW5-2	Md:G-392	19 - 24	11-19-92	<10	<1	57	<.5	<1	<1	<3
OSGW5-3	Md:G-393	27 - 32	11-19-92	<10	<1	55	<.5	<1	<1	<3
OSGW5-4	Md:G-394	40 - 50	11-09-92	20	<1	33	.7	<1	<1	<3
OSGW5-5	Md:G-395	83 - 93	11-19-92	10	<1	47	<.5	<1	<1	<3
OSGW5-6	Md:G-396	113 - 123	11-23-92	<10	<1	20	<.5	2	<1	<3
OSGW6-1	Md:G-397	10 - 15	11-06-92	<10	5	76	.8	3	<1	<3
OSGW6-2	Md:G-398	19 - 24	11-07-92	<10	<1	66	<.5	<1	<1	<3
OSGW6-3	Md:G-399	27 - 32	11-08-92	<10	<1	51	.5	<1	<1	<3
OSGW6-4	Md:G-400	50 - 60	11-08-92	<10	<1	43	.6	<1	1	<3
OSGW6-5	Md:G-401	82 - 92	11-08-92	<10	<1	39	<.5	2	<1	<1
OSGW6-6	Md:G-402	120 - 130	11-07-92	<10	<1	17	.7	<1	<1	<3

Table 11. Concentrations of dissolved trace elements detected in water samples collected by pumping 36 wells at offsite stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant site--Continued

Project and map (fig. 11)	Well numbers USGS local for Tennessee	Screened interval below land surface, in feet	Date sampled	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)	Lithium, dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn)	Molybdenum, dissolved (µg/L as Mo)
OSGW1-1	Md:G-367	13 - 18	10-22-92	<1	640	<1	<4	600	<10
OSGW1-2	Md:G-368	19 - 24	10-22-92	<1	14	<1	<4	130	<10
OSGW1-3	Md:G-369	27 - 32	10-22-92	1	13	<1	<4	48	<10
OSGW1-4	Md:G-370	42 - 52	11-04-92	1	10	<1	7	32	<10
OSGW1-5	Md:G-371	92 - 102	11-04-92	<1	11	<1	<4	4	<10
OSGW1-6	Md:G-372	128 - 138	11-04-92	2	5	<1	<4	49	<10
OSGW2-1	Md:G-373	10 - 15	10-22-92	<1	70	<1	<4	1,600	<10
OSGW2-2	Md:G-374	17 - 22	10-23-92	<1	13	<1	<4	260	<10
OSGW2-3	Md:G-375	24 - 29	10-23-92	<1	7	<1	<4	6	<10
OSGW2-4	Md:G-376	62 - 72	11-06-92	<1	7	<1	<4	15	<10
OSGW2-5	Md:G-377	92 - 102	11-06-92	1	5	<1	5	3	<10
OSGW2-6	Md:G-378	127 - 137	11-05-92	<1	11	<1	<4	31	<10
OSGW3-1	Md:G-379	9 - 14	10-28-92	<1	1,100	<1	<4	660	<10
OSGW3-2	Md:G-380	15 - 20	10-28-92	<1	11	<1	<4	72	<10
OSGW3-3	Md:G-381	24 - 29	10-30-92	<1	5	<1	<4	4	<10
OSGW3-4	Md:G-382	36 - 46	10-29-92	<1	10	<1	<4	21	<10
OSGW3-5	Md:G-383	68 - 78	10-29-92	<1	6	<1	<4	19	<10
OSGW3-6	Md:G-384	138 - 148	11-03-92	3	67	<1	<4	80	<10
OSGW4-1	Md:G-385	10 - 15	11-20-92	<1	2,800	<1	<4	1,200	<10
OSGW4-2	Md:G-386	22 - 27	11-20-92	<1	8	<1	<4	450	<10
OSGW4-3	Md:G-387	36 - 41	11-20-92	<1	9	<1	<4	4	<10
OSGW4-4	Md:G-388	48 - 58	11-20-92	<1	9	<1	<4	8	<10
OSGW4-5	Md:G-389	78 - 89	11-23-92	<1	8	<1	<4	34	<10
OSGW4-6	Md:G-390	117 - 127	11-20-92	<1	7	<1	<4	97	<10
OSGW5-1	Md:G-391	12 - 17	11-19-92	<1	9,200	<1	<4	2,700	<10
OSGW5-2	Md:G-392	19 - 24	11-19-92	<1	9	<1	<4	4	<10
OSGW5-3	Md:G-393	27 - 32	11-19-92	<1	8	<1	<4	7	<10
OSGW5-4	Md:G-394	40 - 50	11-09-92	2	21	<1	<4	34	<10
OSGW5-5	Md:G-395	83 - 93	11-19-92	<1	5	<1	5	16	<10
OSGW5-6	Md:G-396	113 - 123	11-23-92	1	5	<1	<4	84	<10
OSGW6-1	Md:G-397	10 - 15	11-06-92	<1	20,000	<1	<4	2,300	<10
OSGW6-2	Md:G-398	19 - 24	11-07-92	1	20	<1	<4	25	<10
OSGW6-3	Md:G-399	27 - 32	11-08-92	2	15	<1	<4	29	<10
OSGW6-4	Md:G-400	50 - 60	11-08-92	<1	6	<1	<4	13	<10
OSGW6-5	Md:G-401	82 - 92	11-08-92	2	8	<1	<4	19	<10
OSGW6-6	Md:G-402	120 - 130	11-07-92	1	7	<1	<4	6	<10

Table 11. Concentrations of dissolved trace elements detected in water samples collected by pumping 36 wells at offsite stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant site--Continued

Project and map (fig. 11)	Well numbers, USGS local for Tennessee	Screened interval below land surface, in feet	Date sampled	Nickel, dissolved ($\mu\text{g/L}$ as Ni)	Selenium, dissolved ($\mu\text{g/L}$ as Se)	Silver, dissolved ($\mu\text{g/L}$ as Ag)	Strontium, dissolved ($\mu\text{g/L}$ as Sr)	Vanadium, dissolved ($\mu\text{g/L}$ as V)	Zinc, dissolved ($\mu\text{g/L}$ as Zn)
OSGW1-1	Md:G-367	13 - 18	10-22-92	3	<1	<1	100	<6	30
OSGW1-2	Md:G-368	19 - 24	10-22-92	4	<1	<1	120	<6	14
OSGW1-3	Md:G-369	27 - 32	10-22-92	5	<1	<1	48	<6	13
OSGW1-4	Md:G-370	42 - 52	11-04-92	2	1	<1	120	<6	53
OSGW1-5	Md:G-371	92 - 102	11-04-92	<1	<1	<1	60	<6	26
OSGW1-6	Md:G-372	128 - 138	11-04-92	2	<1	<1	95	<6	45
OSGW2-1	Md:G-373	10 - 15	10-22-92	15	<1	<1	120	<6	31
OSGW2-2	Md:G-374	17 - 22	10-23-92	2	1	<1	120	<6	14
OSGW2-3	Md:G-375	24 - 29	10-23-92	2	3	<1	120	<6	5
OSGW2-4	Md:G-376	62 - 72	11-06-92	<1	2	<1	140	<6	18
OSGW2-5	Md:G-377	92 - 102	11-06-92	3	1	<1	85	<6	19
OSGW2-6	Md:G-378	127 - 137	11-05-92	1	<1	<1	72	<6	8
OSGW3-1	Md:G-379	9 - 14	10-28-92	4	<1	<1	92	<6	12
OSGW3-2	Md:G-380	15 - 20	10-28-92	3	<1	<1	130	<6	11
OSGW3-3	Md:G-381	24 - 29	10-30-92	<1	2	<1	110	<6	7
OSGW3-4	Md:G-382	36 - 46	10-29-92	<1	3	<1	120	<6	31
OSGW3-5	Md:G-383	68 - 78	10-29-92	<1	3	<1	110	<6	17
OSGW3-6	Md:G-384	138 - 148	11-03-92	2	<1	<1	70	<6	27
OSGW4-1	Md:G-385	10 - 15	11-20-92	2	<1	<1	50	<6	<3
OSGW4-2	Md:G-386	22 - 27	11-20-92	<1	<1	<1	100	<6	6
OSGW4-3	Md:G-387	36 - 41	11-20-92	<1	<1	<1	38	<6	4
OSGW4-4	Md:G-388	48 - 58	11-20-92	<1	<1	<1	56	<6	15
OSGW4-5	Md:G-389	78 - 89	11-23-92	1	<1	<1	55	<6	7
OSGW4-6	Md:G-390	117 - 127	11-20-92	<1	<1	<1	40	<6	15
OSGW5-1	Md:G-391	12 - 17	11-19-92	1	<1	<1	110	<6	18
OSGW5-2	Md:G-392	19 - 24	11-19-92	<1	1	<1	100	<6	8
OSGW5-3	Md:G-393	27 - 32	11-19-92	<1	1	<1	100	<6	16
OSGW5-4	Md:G-394	40 - 50	11-09-92	2	1	<1	80	<6	160
OSGW5-5	Md:G-395	83 - 93	11-19-92	<1	<1	<1	94	<6	7
OSGW5-6	Md:G-396	113 - 123	11-23-92	2	<1	<1	62	<6	4
OSGW6-1	Md:G-397	10 - 15	11-06-92	4	<1	<1	78	6	12
OSGW6-2	Md:G-398	19 - 24	11-07-92	1	1	<1	140	<6	7
OSGW6-3	Md:G-399	27 - 32	11-08-92	2	1	<1	180	<6	7
OSGW6-4	Md:G-400	50 - 60	11-08-92	<1	1	<1	92	<6	12
OSGW6-5	Md:G-401	82 - 92	11-08-92	1	<1	<1	120	<6	27
OSGW6-6	Md:G-402	120 - 130	11-07-92	<1	<1	<1	84	<6	8

the Fort Pillow aquifer, at concentrations ranging between 9 and 180 $\mu\text{g/L}$ (table 11). These concentrations are below the primary MCL of 1,000 $\mu\text{g/L}$ (Tennessee Division of Health and Environment, 1993). The median barium concentrations for water samples from wells screened in the alluvial aquifer (60 $\mu\text{g/L}$) and the Fort Pillow aquifer (33 $\mu\text{g/L}$) are consistent with the median barium concentration reported for U.S. public water supplies (43 $\mu\text{g/L}$; Hem, 1985).

Dissolved strontium commonly was detected in offsite ground-water samples at concentrations ranging between 38 and 180 $\mu\text{g/L}$ (table 11). The median strontium concentrations for water samples collected from the alluvial aquifer (110 $\mu\text{g/L}$) and Fort Pillow aquifer (85 $\mu\text{g/L}$) are consistent with the median value of strontium concentration reported for U.S. public water supplies (110 $\mu\text{g/L}$; Hem, 1985).

Selected water-quality characteristics and concentrations of dissolved major inorganic constituents were measured in water samples from the 36 wells at the offsite stations (table 12). Generally, median values for dissolved solids, hardness, and specific conductance were higher in samples from wells screened in the alluvial aquifer, compared to those from wells screened in the Fort Pillow aquifer. The range of pH in water samples from the alluvial aquifer (5.3 to 6.5) was comparable to the pH range measured in samples from the Fort Pillow aquifer (5.4 to 6.5) (table 12).

Dissolved major inorganic constituent concentrations in offsite water samples did not differ significantly between the alluvial aquifer and the Fort Pillow aquifer (fig. 13). Mean values of selected major inorganic constituent concentrations were generally higher in the alluvial aquifer, particularly for chloride and sulfate.

Dissolved chloride concentrations, and values for dissolved solids and hardness were high in water samples from wells screened in the alluvial aquifer at stations OSGW5 and OSGW6, compared to concentrations of these constituents in other water samples from the alluvial aquifer (table 12). High chloride, dissolved solids, and hardness concentrations are not specific indicators of contamination from the wood-preserving processes; however, higher concentrations of these constituents and characteristics indicate slight degradation of water quality in alluvial aquifer wells at stations OSGW5

and OSGW6. This interpretation is consistent with the measurement of BTEX compounds and trichloroethylene in water samples from these wells screened in the alluvial aquifer.

POTENTIAL FOR WATER-SUPPLY CONTAMINATION

Potential for contamination of water-supply wells was assessed during this investigation because of concern that contaminants from the ACW site may have reached upgradient municipal wells at the JUD South Well Field east of the site, or down-gradient domestic, industrial, and agricultural-supply wells west of the site (fig. 14). Many of these wells are screened in the Fort Pillow aquifer (table 13). The regional ground-water flow direction in the Fort Pillow aquifer generally is from east to west in the area of the South Well Field and the ACW site (Parks and Carmichael, 1990a, fig. 2), neglecting the effects of pumping at the well field.

Concern about contamination problems at the JUD South Well Field (fig. 14) and a need for hydrologic information to plan a well-head protection program for the JUD North and South Well Fields were the impetus for two previous USGS investigations. A pilot study was conducted to assess data needs and to demonstrate several methods for a preliminary delineation of areas contributing water to the JUD well fields (Broshears and others, 1991). A second study included the use of a computer model to simulate the three-dimensional ground-water-flow system in the sand aquifers in the Jackson area for hydrologic conditions in April 1989. A particle-tracking-program was applied to output from the flow model to determine areas contributing water to the JUD well fields (Bailey, 1993).

For this investigation, the particle-tracking program was used to determine whether water from the area of the ACW site could have reached the JUD South Well Field under pumping conditions in 1978, a time when pumping at this well field was at a maximum. Although the simulation showed that most ground water from the area of the ACW site traveled southward to the South Fork Forked Deer River, some particles of water were shown to be deflected toward the South Well Field because of

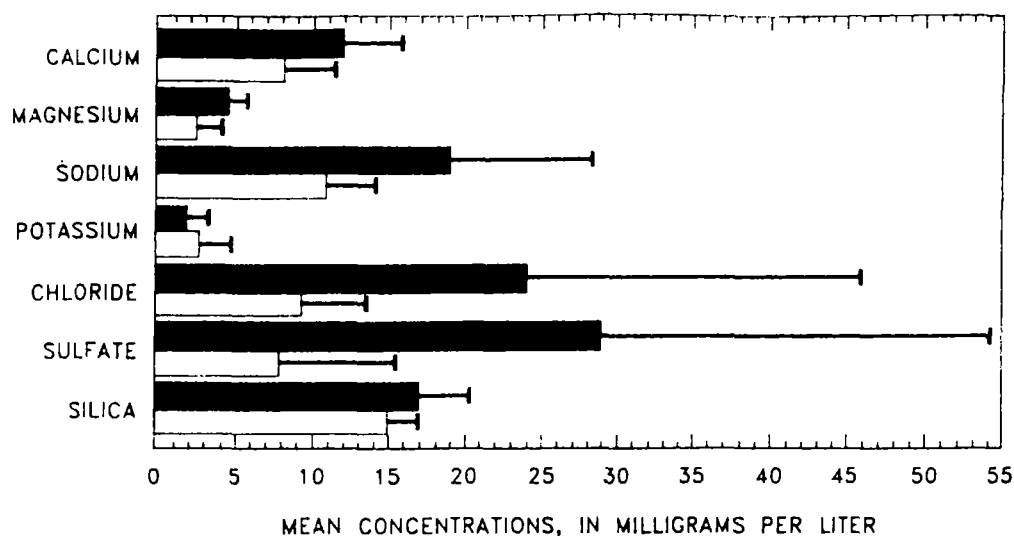
Table 12. Water-quality characteristics and concentrations of major inorganic constituents in water samples from 36 wells at offsite stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant site

[USGS, U.S. Geological Survey; °C, degree Celsius; $\mu\text{S}/\text{cm}$, microsiemens per centimeter; mg/L, milligrams per liter. Values given as < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent]

Well numbers		Screened Interval below land surface, in feet	Date sampled	Field temper- ature water (°C)	Field pH (standard units)	Field specific conductance ($\mu\text{S}/\text{cm}$ at 25°C)	Solids, residue at 180 °C dissolved (mg/L)	Field alka- linity (mg/L as CaCO_3)	Hard- ness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L as Ca)
Project and map	USGS local for Tennessee									
OSGW1-1	Md:G-367	13 - 18	10-22-92	18.3	5.8	194	130	16	44	11
OSGW1-2	Md:G-368	19 - 24	10-22-92	19.8	5.5	204	128	14	45	11
OSGW1-3	Md:G-369	27 - 32	10-22-92	18.3	5.7	145	86	10	36	9.4
OSGW1-4	Md:G-370	42 - 52	11-04-92	21.1	6.3	184	121	35	53	16
OSGW1-5	Md:G-371	92 - 102	11-04-92	20.5	6.0	96	72	28	28	7.6
OSGW1-6	Md:G-372	128 - 138	11-04-92	15.4	6.2	96	69	24	22	5.5
OSGW2-1	Md:G-373	10 - 15	10-22-92	18.9	5.6	237	150	24	54	12
OSGW2-2	Md:G-374	17 - 22	10-23-92	18.5	6.1	209	131	20	50	12
OSGW2-3	Md:G-375	24 - 29	10-23-92	18.4	6.5	206	136	23	53	13
OSGW2-4	Md:G-376	62 - 72	11-06-92	19.4	6.3	201	132	28	62	15
OSGW2-5	Md:G-377	92 - 102	11-06-92	15.4	6.0	127	100	32	32	8.5
OSGW2-6	Md:G-378	127 - 137	11-05-92	18.8	6.5	110	71	28	28	7.9
OSGW3-1	Md:G-379	9 - 14	10-28-92	19.0	5.9	195	124	14	43	10
OSGW3-2	Md:G-380	15 - 20	10-28-92	18.3	6.0	247	164	26	59	14
OSGW3-3	Md:G-381	24 - 29	10-30-92	17.2	6.1	217	135	21	53	13
OSGW3-4	Md:G-382	36 - 46	10-29-92	19.9	6.5	198	128	27	47	12
OSGW3-5	Md:G-383	68 - 78	10-29-92	18.9	6.5	181	118	26	40	10
OSGW3-6	Md:G-384	138 - 148	11-03-92	16.8	5.9	74	64	23	19	5.3
OSGW4-1	Md:G-385	10 - 15	11-20-92	18.6	5.9	127	66	24	24	5
OSGW4-2	Md:G-386	22 - 27	11-20-92	18.0	5.6	201	124	14	49	12
OSGW4-3	Md:G-387	36 - 41	11-20-92	18.5	5.8	63	40	13	14	3.5
OSGW4-4	Md:G-388	48 - 58	11-20-92	18.8	5.6	84	68	12	18	4.6
OSGW4-5	Md:G-389	78 - 89	11-23-92	17.4	5.9	81	48	18	15	4.1
OSGW4-6	Md:G-390	117 - 127	11-20-92	16.7	5.7	34	26	19	9	2.6
OSGW5-1	Md:G-391	12 - 17	11-19-92	19.2	6.0	305	159	32	50	13
OSGW5-2	Md:G-392	19 - 24	11-19-92	17.1	5.4	263	156	10	50	12
OSGW5-3	Md:G-393	27 - 32	11-19-92	20.0	5.3	261	152	11	54	13
OSGW5-4	Md:G-394	40 - 50	11-09-92	17.0	5.9	168	99	24	42	12
OSGW5-5	Md:G-395	83 - 93	11-19-92	16.9	5.4	110	93	24	28	7.3
OSGW5-6	Md:G-396	113 - 123	11-23-92	16.4	5.7	74	55	12	14	3.6
OSGW6-1	Md:G-397	10 - 15	11-06-92	19.7	6.0	200	107	36	33	8.4
OSGW6-2	Md:G-398	19 - 24	11-07-92	18.4	5.6	361	224	12	68	17
OSGW6-3	Md:G-399	27 - 32	11-08-92	19.1	5.4	430	292	7	91	23
OSGW6-4	Md:G-400	51 - 61	11-08-92	16.6	5.8	197	121	19	49	12
OSGW6-5	Md:G-401	82 - 92	11-08-92	16.9	5.8	141	108	27	37	10
OSGW6-6	Md:G-402	120 - 130	11-07-92	15.7	5.9	74	56	18	20	5.9

Table 12. Water-quality characteristics and concentrations of major inorganic constituents in water samples from 36 wells at offsite stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant site--
Continued

Well numbers		Screened Interval below land surface, in feet	Date sampled	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO ₄)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO ₂)
Project and map	USGS local for Tennessee									
OSGW1-1	Md:G-367	13 - 18	10-22-92	3.9	17	1.6	13	40	<0.1	19
OSGW1-2	Md:G-368	19 - 24	10-22-92	4.1	18	1.8	14	43	< .1	20
OSGW1-3	Md:G-369	27 - 32	10-22-92	2.9	10	1.6	2.9	12	< .1	15
OSGW1-4	Md:G-370	42 - 52	11-04-92	3.2	12	4.2	14	7.1	< .1	13
OSGW1-5	Md:G-371	92 - 102	11-04-92	2.1	9.2	2.1	2.1	3.8	.1	14
OSGW1-6	Md:G-372	128 - 138	11-04-92	1.9	12	1.5	7	7.3	< .1	14
OSGW2-1	Md:G-373	10 - 15	10-22-92	5.9	21	1.4	15	53	< .1	21
OSGW2-2	Md:G-374	17 - 22	10-23-92	4.7	16	1.6	16	33	< .1	12
OSGW2-3	Md:G-375	24 - 29	10-23-92	5.0	15	1.6	15	22	< .1	14
OSGW2-4	Md:G-376	62 - 72	11-06-92	6.0	14	2.0	13	27	< .1	19
OSGW2-5	Md:G-377	92 - 102	11-06-92	2.7	12	5.6	10	5.3	< .1	14
OSGW2-6	Md:G-378	127 - 137	11-05-92	2.1	11	1.1	8.1	2.4	< .1	14
OSGW3-1	Md:G-379	9 - 14	10-28-92	4.4	17	1.3	13	45	< .1	20
OSGW3-2	Md:G-380	15 - 20	10-28-92	5.8	20	1.7	15	53	< .1	15
OSGW3-3	Md:G-381	24 - 29	10-30-92	4.9	16	1.7	16	29	< .1	12
OSGW3-4	Md:G-382	36 - 46	10-29-92	4.1	15	3.3	15	17	< .1	13
OSGW3-5	Md:G-383	68 - 78	10-29-92	3.6	15	1.6	14	16	< .1	13
OSGW3-6	Md:G-384	138 - 148	11-03-92	1.3	10	1.4	6.8	3.4	< .1	16
OSGW4-1	Md:G-385	10 - 15	11-20-92	2.7	7.2	1.0	8.6	12	< .1	22
OSGW4-2	Md:G-386	22 - 27	11-20-92	4.5	15	2.2	19	24	< .1	15
OSGW4-3	Md:G-387	36 - 41	11-20-92	1.3	5.4	1.0	5.0	1.5	< .1	14
OSGW4-4	Md:G-388	48 - 58	11-20-92	1.6	8.0	3.0	8.0	2.0	< .1	14
OSGW4-5	Md:G-389	78 - 89	11-23-92	1.2	8.8	1.4	6.8	2.4	< .1	14
OSGW4-6	Md:G-390	117 - 127	11-20-92	0.6	5.6	1.4	0.9	1.7	< .1	13
OSGW5-1	Md:G-391	12 - 17	11-19-92	4.3	25	2.7	45	27	< .1	22
OSGW5-2	Md:G-392	19 - 24	11-19-92	4.9	24	2.1	38	24	< .1	16
OSGW5-3	Md:G-393	27 - 32	11-19-92	5.3	21	2.3	33	24	< .1	15
OSGW5-4	Md:G-394	40 - 50	11-09-92	3.0	12	1.5	12	13	.3	17
OSGW5-5	Md:G-395	83 - 93	11-19-92	2.3	8.8	9.0	10	4.1	< .1	16
OSGW5-6	Md:G-396	113 - 123	11-23-92	1.1	7.1	1.3	7.7	1.3	< .1	15
OSGW6-1	Md:G-397	10 - 15	11-06-92	2.9	9.7	1.9	8.7	11	.1	23
OSGW6-2	Md:G-398	19 - 24	11-07-92	6.2	39	2.6	69	26	< .1	18
OSGW6-3	Md:G-399	27 - 32	11-08-92	8.2	41	2.8	80	39	< .1	18
OSGW6-4	Md:G-400	51 - 61	11-08-92	4.5	17	1.8	17	22	< .1	19
OSGW6-5	Md:G-401	82 - 92	11-08-92	2.9	13	2.9	11	7.0	< .1	16
OSGW6-6	Md:G-402	120 - 130	11-07-92	1.3	5.8	1.3	5.2	1.2	< .1	15



EXPLANATION

- 18 WELLS AT OFFSITE STATIONS OSGW1 THROUGH OSGW6, SCREENED IN ALLUVIAL AQUIFER
- 18 WELLS AT OFFSITE STATIONS OSGW1 THROUGH OSGW6, SCREENED IN FORT PILLOW AQUIFER
- STANDARD DEVIATION OF MEAN CONCENTRATION VALUE

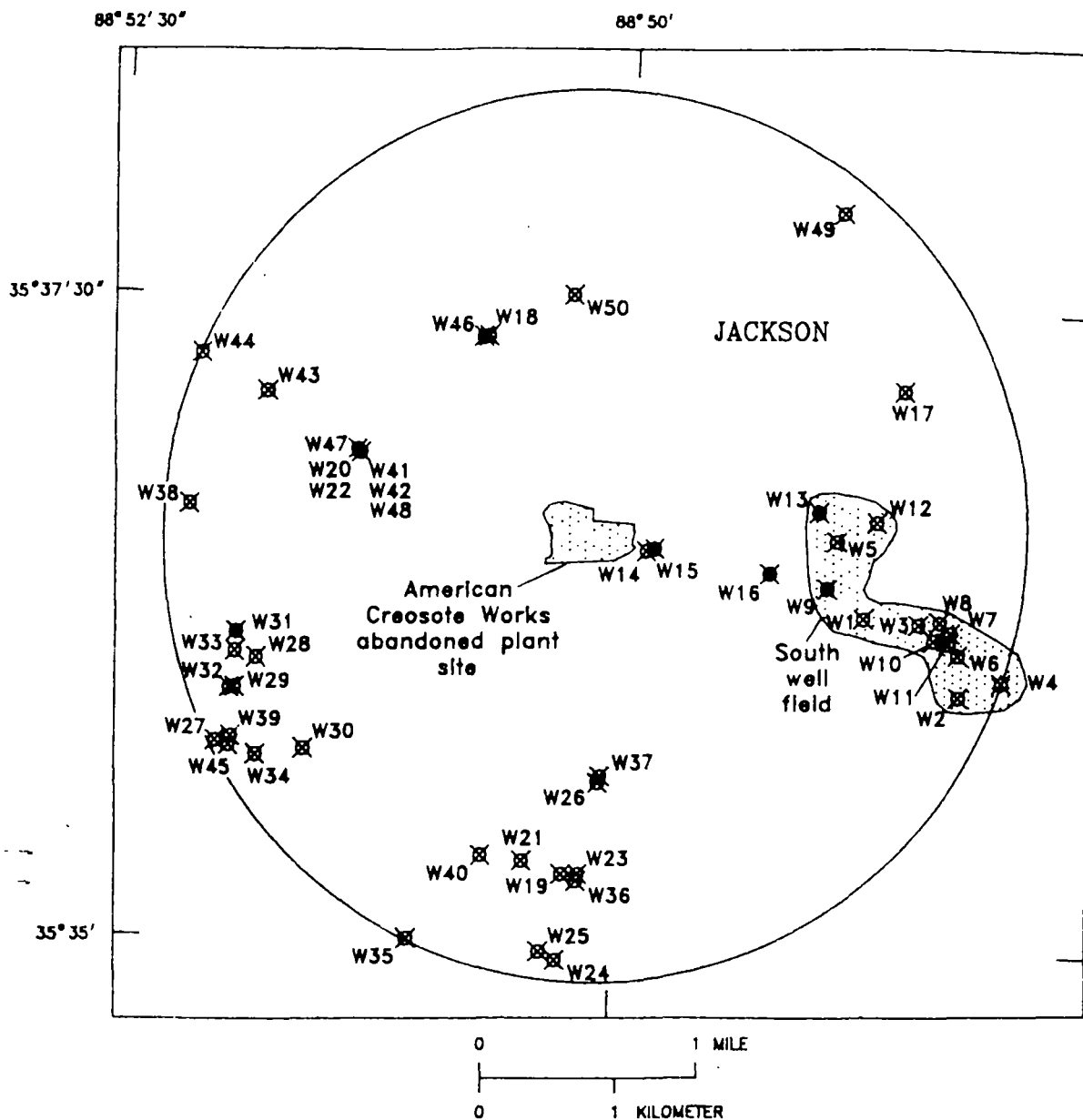
Figure 13. Mean concentrations and standard deviations for major inorganic constituents measured in water samples from 18 wells screened in the alluvial aquifer and 18 wells screened in the Fort Pillow aquifer at offsite stations OSGW1 through OSGW6 near the American Creosote Works abandoned plant site.

pumping stress at the well field. However, simulations for 10- and 20-year time-of-travel indicated that particles originating at the ACW site and traveling toward the South Well Field did not travel far enough to reach the nearest wells in the well field (Z.C. Bailey, U.S. Geological Survey, written commun., 1990).

Seven water-supply wells were sampled for water quality during November to December 1992 and January 1993 to determine whether contaminants associated with the wood-preserving processes could be detected in the Fort Pillow or alluvial aquifers upgradient or downgradient from the ACW site. These wells were selected from an inventory of 50 water-supply wells (table 13) located within a 2-mile radius of the ACW site (fig. 14). The sam-

ples were analyzed for the same VOC's and SVC's (table 9), trace elements (table 11), and water-quality characteristics and major constituents in ground water (table 12) as the samples from the 36 wells installed at offsite stations OSGW1 through OSGW6 near the ACW site.

Wells W9 and W13 are JUD municipal wells (table 13) that were installed in 1968 and 1975, and both are located about 1 mile east of the ACW site (fig. 14). These wells are 129 and 159 feet deep, respectively, and are screened in the Fort Pillow aquifer. VOC's were detected in water samples collected from both wells on November 24, 1992, and January 25, 1993 (table 14). Chloroform was detected at concentrations of 0.2 $\mu\text{g/L}$ (wells W9 and W13, both samples). Tetrachloroethylene



EXPLANATION

W35 ✕ WATER-SUPPLY WELL AND NUMBER

W31 ■ WATER-SUPPLY WELL SAMPLED FOR
WATER QUALITY AND NUMBER

Figure 14. Location of the Jackson Utility Division South Well Field, water-supply wells inventoried within a 2-mile radius of the American Creosote Works abandoned plant site, and 7 wells from which samples were collected for water-quality analysis.

Table 13. Records of water-supply wells inventoried within a 2-mile radius of the American Creosote Works abandoned plant site

[These records were located in the files of the Tennessee Department of Environment and Conservation (TDEC), Division of Ground Water Protection, the Jackson Utility Division (JUD), and the U.S. Geological Survey. Water-bearing units are: MCNR - McNairy Sand, FRPL - Fort Pillow Sand, MMPS - Memphis Sand, TRRC - terrace deposits (fluvial deposits), ALVM - alluvium. Use of water: M - municipal, I - industrial, C - commercial, A - agricultural, D - Domestic, U - unused. --, indicates that the data were not reported in the records. Numbers in parentheses after JUD wells follow their numbering system; those after other wells are the TDEC system.]

Project and map	Well numbers USGS local for Tennessee	Well owner	Date drilled	Altitude, in feet	Well depth, in feet	Water-bearing unit	Well diameter, in inches	Screen length, in feet	Water level below land surface		Pumping or flow rate, in gallons per minute	Use of water
									Depth, in feet	Date		
W1	Md:G-1	Jackson Utility Division (fountain at water plant)	1902	359	529	MCNR	12	--	flows	1902	300	U
W2	Md:G-10	Jackson Utility Division (7)	1952	352	147	FRPL	12 X 10	50	56	1978	1,016	U
W3	Md:G-12	Jackson Utility Division (9)	1959	358	157	FRPL	12	50	49	1959	1,200	M
W4	Md:G-14	Jackson Utility Division (8)	1961	360	168	FRPL	12	50	--	--	--	U
W5	Md:G-52	Jackson Utility Division (11)	1968	383	166	FRPL	12	40	45	1968	750	M
W6	Md:G-53	Jackson Utility Division (6)	1952	363	155	FRPL	12 X 10	40	38	1952	1,280	M
W7	Md:G-88	Jackson Utility Division (4)	1964	361	148	FRPL	12	50	42	1964	675	M
W8	Md:G-89	Jackson Utility Division (3)	1964	361	150	FRPL	12	50	42	1964	1,000	M
W9	Md:G-278	Jackson Utility Division (12)	1968	360	129	FRPL	12	40	2	1968	750	M
W10	Md:G-279	Jackson Utility Division (2)	1964	353	150	FRPL	12	50	46	1964	850	M
W11	Md:G-280	Jackson Utility Division (5)	1961	355	176	FRPL	12	68	66	1961	1,016	M
W12	Md:G-281	Jackson Utility Division (10)	1972	400	140	FRPL	12	50	63	1972	--	M
W13	Md:G-283	Jackson Utility Division (13)	1975	388	159	FRPL	12	50	60	1975	--	M
W14	Md:G-327	Morgan Lumber Company	--	352	30?	ALVM	4	10	8	1992	--	I
W15	Md:G-328	Morgan Lumber Company	--	352	--	MCNR	--	--	flows	1990	--	U
W16	Md:G-329	Jackson Wood Products (217) (once Ashby Vencer & Lbr.Co.)	1964	359	132	FRPL	6	27	18	1964	160	I
W17	Md:G-330	The Beare Company (659)	1968	432	149	FRPL	8	20	95	1968	250	I
W18	Md:G-331	UT Agri. Exper. Sta. (835)	1969	365	90	MMPS	4	18	45	1969	100	A
W19	Md:G-332	V.L. Stewart (1079)	1971	352	58	FRPL	4	4	20	1971	--	D
W20	Md:G-333	City Concrete (1175)	1972	338	130	FRPL	4	20	--	1972	--	I
W21	Md:G-334	A.L. Williams (1336)	1973	355	40	ALVM	2	4	20	1973	--	D
W22	Md:G-335	City Concrete (1658)	1976	338	122	FRPL	4	20	--	--	--	I
W23	Md:G-336	Wayne Vann (1836)	1977	349	37	ALVM	4	10	2	1977	--	D
W24	Md:G-337	W. Jobe Robinson (1869)	1978	365	165	FRPL	4	10	120	1978	10	D
W25	Md:G-338	Paul Smith (1935)	1978	373	93	FRPL	4	5	25	1978	10	D

Table 13. Records of water-supply wells inventoried within a 2-mile radius of the American Creosote Works abandoned plant site--Continued

Project and map	Well numbers USGS local for Tennessee	Well owner	Date drilled	Altitude, in feet	Well depth, in feet	Water-bearing unit	Well diameter, in inches	Screen length, in feet	Water level below land surface		Pumping or flow rate, in gallons per minute	Use of water
									Depth, in feet	Date		
W26	Md:G-339	Murray Ragan (2263)	1981	342	60	FRPL	4	10	30	1981	—	D
W27	Md:G-340	George Robinson (2299)	1980	408	120	MMPS	4	5	80	1980	10	D
W28	Md:G-341	J.H. Webb (255)	1964	362	69	MMPS	2	5	22	1964	—	D
W29	Md:G-342	Donald Edwards (583)	1968	373	110	FRPL	2	6	20	1968	6	D
W30	Md:G-343	J.W. Austin (831)	1969	370	59	MMPS	4	5	40	1969	—	D
W31	Md:G-344	Taylor Roebuck (1042)	1971	350	90	FRPL	2	5	15	1971	7	D
W32	Md:G-345	Edd Trammell (1138)	1971	375	92	MMPS	4	4	60	1971	15	D
W33	Md:G-346	Charles Graves (2801)	1985	360	73	MMPS	4	40	40	1985	10	D
W34	Md:G-347	Lacey Rose (3209)	1988	394	120	FRPL	4	10	40	1988	18	D
W35	Md:G-348	Turner Dairy (3104)	1987	432	180	FRPL	4	40	—	—	—	I
W36	Md:G-349	Betty Plunk (2825)	1985	350	38	ALVM	4	10	3	1985	12	D
W37	Md:G-350	Top Star Grocery (937)	1970	345	53	FRPL	4	5	28	1970	50	C
W38	Md:G-351	Albert Fly (379)	1966	343	35	ALVM	1 1/4	6	18	1966	—	U
W39	Md:G-352	Thomas Springer (994)	1971	423	118	MMPS	4	4	80	1971	15	D
W40	Md:G-353	Keith Turner (1260)	1972	367	40	TRRC	1 1/4	4	25	1972	7	D
W41	Md:G-354	City Concrete (3081)	1986	338	90	FRPL	4	20	10	1986	50	I
W42	Md:G-355	City Concrete (2628)	1983	338	105	FRPL	4	20	10	1983	—	I
W43	Md:G-356	Euther Davidson (1263)	1972	338	42	ALVM	2	4	19	1972	—	C
W44	Md:G-357	Nicks Construction (2024) (once Mid South Materials)	1978	338	90	FRPL	4	20	—	—	30	I
W45	Md:G-358	D.W. Morris (328)	1965	422	113	MMPS	2	4	80	1965	—	D
W46	Md:G-403	UT Agricultural Exp. Station	1987	365	190	FRPL	6	30	—	—	120	A
W47	Md:G-404	City Concrete	1988	338	140	FRPL	6	40	—	—	160	I
W48	Md:G-405	City Concrete (3226)	1988	338	165	FRPL	4	10	—	—	30	I
W49	Md:M-571	James Avent (2609)	1983	452	145	MMPS	4	10	50	1983	10	A
W50	Md:M-572	Sun and Swim (1716)	1976	362	138	FRPL	4	16	60	1976	25	C

Table 14. Concentrations of volatile organic compounds detected in water samples collected from seven water wells within a 2-mile radius of the American Creosote Works abandoned plant site, November 1992-January 1993

[Concentrations are in micrograms per liter ($\mu\text{g/L}$); (TDEC) Tennessee Department of Environment and Conservation, 1993, (MCL) primary maximum contaminant levels for drinking water; values given as < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a compound; "none" indicates no established maximum contaminant level for the compound; -- indicates no second sample collected]

Synthetic organic compound	Analytical method minimum detection limit	Wells in which detected	Concentration detected		TDEC MCL
			First sample	Second sample	
Chloroform	0.2	W9 (Md:G-278)	0.2	0.2	none
		W13 (Md:G-283)	.2	.2	
		W14 (Md:G-327)	.2	--	
		W16 (Md:G-329)	.2	.2	
1,1-Dichloroethane	.2	W14 (Md:G-327)	.3	--	none
cis-1,2-Dichloroethylene	.2	W16 (Md:G-329)	< .2	.2	none
Methylene chloride	.2	W14 (Md:G-327)	.3	--	none
		W46 (Md:G-403)	.6	--	
Tetrachloroethylene	.2	W9 (Md:G-278)	2.4	2.5	none
		W13 (Md:G-283)	2.2	3.1	
		W16 (Md:G-329)	45	69	
Trichloroethylene	.2	W14 (Md:G-327)	.2	--	5
		W16 (Md:G-329)	1.1	1.2	
Trichlorofluoromethane	.2	W16 (Md:G-329)	.5	.4	none
Trichlorotrifluoroethane	.5	W14 (Md:G-327)	1.5	--	none

detected at concentrations of 2.4 and 2.5 $\mu\text{g/L}$ (well W9) and at 2.2 and 3.1 $\mu\text{g/L}$ (well W13).

Detection of chloroform and tetrachloroethylene in wells W9 and W13 is consistent with analytical data obtained from these wells in September and November 1987 (Broshears and others, 1991, table 5). These previous analyses showed that chloroform was detected at concentrations of 0.2 and 0.3 $\mu\text{g/L}$ (well W9) and 0.3 $\mu\text{g/L}$ in both samples (well W13). Methylene chloride also was detected at a concentration of 1.2 $\mu\text{g/L}$ previously in a 1987 sample from well W13 (Broshears and others,

1991, table 5), but was not detected in the ground-water samples collected for this investigation.

During September and November 1987, 2 samples were collected from each of 11 wells in the JUD South Well Field and analyzed for 16 VOC's (Broshears and others, 1991, p. 12-13). Tetrachloroethylene was measured in water samples from eight wells at concentrations ranging between 0.2 and 23 $\mu\text{g/L}$ (Broshears and others, 1991, table 5). Trichloroethylene was measured in water samples from three wells at concentrations ranging between 0.3 and 3.3 $\mu\text{g/L}$. Low concentrations of

trans-1,2-dichloroethylene (0.2 to 0.6 $\mu\text{g/L}$) and benzene (0.2 to 1.4 $\mu\text{g/L}$) also were measured in water samples from three wells. Groundwater Management, Inc., (GM) in an unpublished report to JUD, 1987, speculated that the source of these VOC's may be a leaky sewer receiving effluent from a past or present user of the compounds (Broshears and others, 1991, p. 11).

Tetrachloroethylene, trichloroethylene, and their degradation products are among the most commonly observed contaminants found in shallow ground-water systems (Chapelle, 1993, p. 377). Tetrachloroethylene and trichloroethylene are used in great volumes as dry-cleaning fluids, refrigerants, degreasing agents, and solvents. These compounds also are relatively resistant to microbial degradation under conditions commonly found in shallow ground-water systems (Chapelle, 1993, p. 377).

Wells in the JUD South Well Field (fig. 14; table 13) are located within an older part of Jackson that is interspersed with industrial and commercial establishments, including switching yards and maintenance facilities for railroads. Therefore, the occurrence of the tetrachloroethylene, trichloroethylene, and chloroform in the Fort Pillow aquifer at the JUD South Well Field is problematic inasmuch as these compounds may have entered the aquifer from a single source, such as the leaky sewer speculated by GM, or from multiple sources in the well-field area. No VOC's or SVC's commonly associated with the wood-preserving processes were detected in water samples from wells W9 and W13.

Well W16, an industrial well installed in 1964 (table 13), is about 3/4-mile east of the ACW site (fig. 14). This well is 132 feet deep, and is screened in the Fort Pillow aquifer. Several VOC's were detected in water samples collected from this well on November 25, 1992, and January 25, 1993 (table 14). Tetrachloroethylene was detected at concentrations of 45 and 69 $\mu\text{g/L}$, trichloroethylene at 1.1 and 1.2 $\mu\text{g/L}$, trichlorofluoromethane at 0.5 and 0.4 $\mu\text{g/L}$, chloroform at 0.2 $\mu\text{g/L}$ (both samples), and cis-1,2-dichloroethylene at 0.2 $\mu\text{g/L}$ (one sample).

Detection of tetrachloroethylene and trichloroethylene in water samples from well W16 extends the area where these compounds have been detected in samples from water-supply wells screened in the Fort Pillow aquifer about 1/4 mile farther west than

had been determined previously (Broshears and others, 1991). In addition, tetrachloroethylene (45 and 69 $\mu\text{g/L}$) in water samples from well W16 represents higher concentrations than any measured in samples from wells in the JUD South Well Field (Broshears and others, 1991, table 5). These VOC's are not commonly associated with wood-preserving processes, although trichloroethylene has been detected in water samples from the alluvial aquifer beneath the ACW site (Parks and others, 1993).

Well W14 is an industrial well reported to be 30 feet deep (table 13). If the reported depth is accurate, this well is in the alluvial aquifer. Well W14 was sampled in January 1993 because of its proximity (within a few hundred feet) to the ACW site (fig. 14). Chloroform was detected in water sample collected from this well at a concentration of 0.2 $\mu\text{g/L}$, 1,1-dichloroethane at 0.3 $\mu\text{g/L}$, trichloroethylene at 0.2 $\mu\text{g/L}$, and trichlorotrifluoroethane at 1.5 $\mu\text{g/L}$ (table 14). In addition to these VOC's, several trace elements were detected in water samples from this well at relatively high concentrations (table 15). Cadmium was detected at 13 $\mu\text{g/L}$, chromium at 6 $\mu\text{g/L}$, cobalt at 89 $\mu\text{g/L}$, nickel at 13 $\mu\text{g/L}$, and vanadium at 11 $\mu\text{g/L}$. The source of the VOC's and relatively high concentrations of trace elements detected in the water sample from well W14 is problematic inasmuch as the well is not located (fig. 14) in the direction of ground-water flow in the alluvial aquifer from the ACW site (fig. 6). Well W14 is located in an industrial area downgradient from a railroad switching yard and maintenance facility and an old cemetery.

Most contaminants at the ACW site migrate in the alluvial aquifer southwestward toward the South Fork Forked Deer River at depths less than about 35 feet below land surface (Parks and others, 1993). Contaminants in the alluvial aquifer and possibly the upper part of the Fort Pillow aquifer that reach the South Fork Forked Deer River are discharged in ground water entering the river (fig. 7). However, some contaminants migrating at greater depths in the Fort Pillow aquifer may travel under the South Fork Forked Deer River and continue westward along the regional ground-water flow direction in that aquifer (Parks and Carmichael, 1990a, fig. 2). The average ground-water flow velocity for the Fort Pillow

Table 15. Concentrations of dissolved trace elements detected in water samples collected from seven water-supply wells within a 2-mile radius of the American Creosote Works abandoned plant site

[USGS, U.S. Geological Survey; $\mu\text{g/L}$, micrograms per liter. Values given as < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent]

Well numbers		Screened interval below land surface, in feet	Date sampled	Aluminum, dissolved ($\mu\text{g/L}$ as Al)	Arsenic, dissolved ($\mu\text{g/L}$ as As)	Barium, dissolved ($\mu\text{g/L}$ as Ba)	Beryllium, dissolved ($\mu\text{g/L}$ as Be)	Cadmium, dissolved ($\mu\text{g/L}$ as Cd)	Chromium, dissolved ($\mu\text{g/L}$ as Cr)	Cobalt, dissolved ($\mu\text{g/L}$ as Co)
Project and map (fig. 14)	USGS local for Tennessee									
W9	Md:G-278	105 - 155	11-24-92	<10	<1	48	<0.5	<1	<1	<3
W13	Md:G-283	85 - 125	11-24-92	20	<1	49	<.5	<1	<1	<3
W14	Md:G-327	20 - 30	01-26-93	<10	2	71	<.5	13	6	89
W16	Md:G-329	105 - 132	11-25-92	10	<1	47	<.5	<1	8	<3
W31	Md:G-344	85 - 90	12-01-92	10	<1	4	<.5	<1	<1	<3
W46	Md:G-403	160 - 190	11-24-92	<10	<1	11	<.5	<1	<1	<3
W47	Md:G-404	100 - 140	01-26-93	<10	<1	4	<.5	2	4	<3

Well numbers		Screened interval below land surface, in feet	Date sampled	Copper, dissolved ($\mu\text{g/L}$ as Cu)	Iron, dissolved ($\mu\text{g/L}$ as Fe)	Lead, dissolved ($\mu\text{g/L}$ as Pb)	Lithium, dissolved ($\mu\text{g/L}$ as Li)	Manganese, dissolved ($\mu\text{g/L}$ as Mn)	Molybdenum, dissolved ($\mu\text{g/L}$ as Mo)
Project and map (fig. 14)	USGS local for Tennessee								
W9	Md:G-278	105 - 155	11-24-92	2	<3	<1	<4	24	<10
W13	Md:G-283	85 - 125	11-24-92	2	8	3	<4	3	20
W14	Md:G-327	20 - 30	01-26-93	<1	56,000	<1	<4	4,900	<10
W16	Md:G-329	105 - 132	11-25-92	1	16	<1	<4	99	<10
W31	Md:G-344	85 - 90	12-01-92	3	13	<1	<4	<1	<10
W46	Md:G-403	160 - 190	11-24-92	1	43	<1	<4	2	<10
W47	Md:G-404	100 - 140	01-26-93	<1	35	<1	<4	3	<10

Well numbers		Screened interval below land surface, in feet	Date sampled	Nickel, dissolved ($\mu\text{g/L}$ as Ni)	Selenium, dissolved ($\mu\text{g/L}$ as Se)	Silver, dissolved ($\mu\text{g/L}$ as Ag)	Strontium, dissolved ($\mu\text{g/L}$ as Sr)	Vanadium, dissolved ($\mu\text{g/L}$ as V)	Zinc, dissolved ($\mu\text{g/L}$ as Zn)
Project and map (fig. 14)	USGS local for Tennessee								
W9	Md:G-278	105 - 155	11-24-92	<1	<1	<1	170	<6	<3
W13	Md:G-283	85 - 125	11-24-92	1	<1	<1	120	<6	6
W14	Md:G-327	20 - 30	01-26-93	13	<1	<1	500	11	27
W16	Md:G-329	105 - 132	11-25-92	<1	<1	<1	150	<6	6
W31	Md:G-344	85 - 90	12-01-92	<1	<1	<1	6	<6	<3
W46	Md:G-403	160 - 190	11-24-92	<1	<1	<1	16	<6	<3
W47	Md:G-404	100 - 140	01-26-93	<1	<1	<1	12	<6	7

aquifer calculated for this investigation--10 feet per year--indicates that contaminants entering the ground-water flow system 50 years ago may have migrated about 500 feet downgradient from the ACW site. The maximum flow velocity calculated for the Fort Pillow aquifer--130 feet per year--indicates that contaminants may have migrated to distances of about 1 1/4 miles downgradient from the site.

The closest wells west of the ACW site are about 1 to 1 1/2 miles distant (fig. 14). These wells range in depth from about 60 to 190 feet and are screened in the Memphis aquifer (Parks and Carmichael, 1990b) or the Fort Pillow aquifer (table 13). Three wells (W31, W46, and W47) screened in the Fort Pillow aquifer were sampled to determine if contaminants could be detected in the ground water downgradient from the site (fig. 14).

Well W31 is a domestic well 90-feet deep, well W46 is an agricultural well 190-feet deep, and well W47 is an industrial well 140-feet deep (table 13). No VOC's or SVC's were detected in water samples collected from these wells in November 1992 to January 1993, except for methylene chloride at a concentration of 0.6 µg/L in well W46 (table 14). Methylene chloride commonly is used in water-quality laboratories and may have been detected in the water sample from well W46 as a laboratory contaminant.

Water-quality characteristics and concentrations of dissolved major inorganic constituents were measured for the first samples collected from the seven water-supply wells sampled during this investigation (table 16). Comparison of water-quality data from wells W9, W13, W16, W31, W46, and W47 with minimum, median, and maximum concentrations

Table 16. Water-quality characteristics and concentrations of major inorganic constituents detected in water samples collected from seven water-supply wells within a 2-mile radius of the American Creosote Works abandoned plant site

[USGS, U.S. Geological Survey; °C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter. Values given as < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent; --, indicate no data]

Well numbers		Screened interval below land surface, in feet	Date sampled	Field temperature water (°C)	Field pH (standard units)	Field specific conductance (µS/cm at 25°C)	Solids, residue at 180°C dissolved (mg/L)	Field alkalinity (mg/L as CaCO ₃)	Hardness, total (mg/L as CaCO ₃)	Calcium, dissolved (mg/L as Ca)
Project and map	USGS local for Tennessee									
W9	Md:G-278	105 - 155	11-24-92	16.6	6.2	253	157	36	74	19
W13	Md:G-283	85 - 125	11-24-92	17.2	6.0	198	120	20	54	13
W14	Md:G-327	20 - 30	01-26-93	15.2	6.2	798	476	121	191	50
W16	Md:G-329	105 - 132	11-25-92	16.9	6.0	261	150	35	75	20
W31	Md:G-344	85 - 90	12-01-92	16.0	5.6	27	33	13	5	1.2
W46	Md:G-403	160 - 190	11-24-92	15.6	5.8	37	38	9	7	1.8
W47	Md:G-404	100 - 140	01-26-93	--	5.8	33	22	11	7	1.8

Well numbers		Screened interval below land surface, in feet	Date sampled	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO ₄)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO ₂)
Project and map	USGS local for Tennessee									
W9	Md:G-278	105 - 155	11-24-92	6.3	12	5.1	12	50	<0.1	15
W13	Md:G-283	85 - 125	11-24-92	5.3	12	3.1	12	37	< .1	16
W14	Md:G-327	20 - 30	01-26-93	16	28	8.7	91	60	.1	22
W16	Md:G-329	105 - 132	11-25-92	6	15	4.8	16	43	< .1	15
W31	Md:G-344	85 - 90	12-01-92	0.4	2.4	0.5	1.7	0.3	< .1	12
W46	Md:G-403	160 - 190	11-24-92	.7	3.7	.8	3.0	.3	< .1	14
W47	Md:G-404	100 - 140	01-26-92	.6	3.0	.6	1.0	.9	< .1	13

in water samples from six wells screened in the Fort Pillow aquifer in Madison County, Tennessee (Parks and Carmichael, 1989, table 2), indicate that water-quality characteristics and concentrations of major constituents were consistent and show no evidence of contamination. These data also are consistent with major inorganic constituent concentrations measured in water samples from the 18 wells screened in the Fort Pillow aquifer at offsite stations OSGW1 through OSGW6 (table 12).

Some concentrations of dissolved major inorganic constituents measured in the water sample collected from well W14 are elevated (table 16) in comparison to data from the 18 wells screened in the alluvial aquifer at offsite stations OSGW1 through OSGW6. Chloride concentrations and values for dissolved solids and hardness are three to four times higher in the water sample from well W14. Concentrations of these constituents and characteristics, and some trace elements and VOC's, indicate degradation of water quality at well W14, although it is not suspected that this degradation is the result of past activities at the ACW site.

SUMMARY AND CONCLUSIONS

An investigation was conducted by the U.S. Geological Survey at the American Creosote Works (ACW) abandoned plant site at Jackson, Tennessee, to determine the extent and magnitude of ground-water contamination in nearby offsite areas and to assess the potential for water-supply contamination from the site. During its approximate 50-year period of operation (from the 1930's to 1981), activities at the ACW facility caused significant contamination of soil, surface water, and ground water. Both creosote and pentachlorophenol were used in the wood-preserving process, and these compounds are the primary contaminants affecting ground-water quality at the site.

The Fort Pillow Sand of Tertiary age and alluvium of Quaternary age make up the Fort Pillow and alluvial aquifers, parts of which underlie the ACW site. The combined thickness of these aquifers beneath the site is about 150 feet. The uppermost part of the alluvium, which consists primarily of clay, silt, and fine sand, serves as a relatively

thin upper confining unit for the Fort Pillow and alluvial aquifers. Below the Fort Pillow aquifer is a thick section of clay, which serves as a lower confining unit separating the Fort Pillow and alluvial aquifers from the deeper McNairy aquifer. The Fort Pillow and alluvial aquifers, which consist primarily of sand, are not separated by a confining unit of any significant thickness or areal extent. However, differences in silt and clay content in the sands affect contaminant migration in the subsurface beneath the site.

The alluvial and Fort Pillow aquifers beneath the ACW site are semi-confined. Water levels generally are high throughout the year, ranging from 1 to 10 feet below land surface. The potentiometric surfaces in the alluvial and Fort Pillow aquifers at the site slope to the southwest toward the nearby South Fork Forked Deer River. Average ground-water flow velocities in these aquifers are about 17 and 10 feet per year, respectively. The pattern of vertical hydraulic gradient is somewhat complex--downward, indicating recharge, in the northern part of the site, and upward, indicating discharge, in the southern part toward the South Fork Forked Deer River.

Contaminants from the wood-preserving processes have migrated into the subsurface as an oily or non-aqueous phase liquid (NAPL) from onsite sources such as waste lagoons and treatment areas. The NAPL has descended into the alluvial aquifer, and migrated downgradient with ground-water flow and along zones of higher hydraulic conductivity in the alluvial aquifer or the Fort Pillow aquifer, creating a potential for ground-water contamination away from the ACW site.

Four groups of organic compounds detected onsite in the NAPL and ground water were: (1) PAH's, (2) phenolic compounds (including PCP), (3) nitrogen-containing heterocyclic compounds, and (4) VOC's (primarily BTEX's). Maximum concentrations of organic compounds were detected in samples from the onsite alluvial aquifer at depths less than 35 feet below land surface.

Naphthalene, PCP, and quinoline are the principal ground-water contaminants resulting from wood-preserving processes detected onsite. Naphthalene was the most common PAH detected in water samples from the alluvial aquifer. This compound was detected at concentrations ranging between 2 and 7,600 $\mu\text{g/L}$. PCP concentrations

ranged between 80 and 3,200 $\mu\text{g/L}$ in these same samples, with many sample concentrations exceeding the proposed MCL for drinking water of 200 $\mu\text{g/L}$. Quinoline was not detected in any ground-water sample.

VOC's (specifically BTEX's) were contained in solvents used during the wood-preserving processes. Of the BTEX compounds, ethylbenzene was detected at the highest concentrations. Where detected, benzene concentrations exceeded the primary MCL of 0.5 $\mu\text{g/L}$ for drinking water in seven of the nine water samples from the alluvial aquifer at onsite stations.

Few organic compounds were detected in water samples from onsite wells screened in the Fort Pillow aquifer. Naphthalene was the only PAH detected. This compound was measured at a concentration of 2 $\mu\text{g/L}$ at station 3 (125.5-135.5 feet). Other VOC's detected were trichloroethylene at a concentration of 6 $\mu\text{g/L}$ (station 5; 54-55 feet), and methylene chloride in two samples at concentrations of 9 $\mu\text{g/L}$ (station 2; 64-65 feet) and 150 $\mu\text{g/L}$ (station 3; 125.5-135.5 feet).

Ground-water samples collected from offsite stations with the DPT Hydrocone tool were analyzed for PAH's, phenolic compounds (including PCP), and nitrogen-containing heterocyclic compounds using HPLC. Ground-water samples also were analyzed for selected VOC's (including BTEX compounds) using GC/PID. Water samples pumped from the 36 wells at 6 offsite stations were analyzed for selected VOC's and SVC's. Dissolved trace elements and major inorganic constituents also were measured, and water-quality characteristics were determined for these samples.

Relatively low concentrations of naphthalene, trihalomethanes, and other VOC's were detected in water samples from the alluvial aquifer at offsite stations. Naphthalene was detected in a total of five samples from offsite wells screened in the alluvial aquifer. Using the HPLC method, naphthalene was detected at concentrations of 10 $\mu\text{g/L}$ (2 samples), and 20 $\mu\text{g/L}$ (one sample) at depths of 17 to 24 feet. Using the GC/PID method, naphthalene was detected at concentrations of 0.6 and 3.0 $\mu\text{g/L}$ at depths of 10 to 27 feet. Trihalomethanes were detected in one water sample from a well screened in the Fort Pillow aquifer, at a sum concentration (bromoform, chloroform, bromodichloromethane, and dibromochloromethane) of 1.5 $\mu\text{g/L}$.

BTEX's were the most commonly detected VOC's in water samples collected using DPT method and by pumping wells at offsite stations. Considering the BTEX data in ground-water samples collected by the DPT method from the alluvial aquifer, toluene and ethylbenzene concentrations ranged between 2 and 10 $\mu\text{g/L}$, and xylene concentrations ranged between 2 and 790 $\mu\text{g/L}$. Benzene was not detected in any offsite ground-water sample collected by the DPT method. Because of differences in the sampling methods, the concentrations in ground-water samples collected by the DPT method are generally 10 times greater than concentrations detected in samples collected by pumping wells.

BTEX concentrations in water samples pumped from offsite wells screened in the alluvial aquifer ranged between <0.2 and 1.6 $\mu\text{g/L}$, for each compound, where detected. BTEX compounds also were detected in samples pumped from the wells screened in the Fort Pillow aquifer. Benzene was detected at a concentration of 0.2 $\mu\text{g/L}$ in two ground-water samples (82-92 feet and 120-130 feet). Xylenes also were detected at concentrations of 0.9 and 0.7 $\mu\text{g/L}$ in these same samples, respectively.

Concentrations of all organic compounds were low in water samples collected from offsite wells. Sorption of contaminants on clay-mineral surfaces and microbial degradation are suspected to have limited the migration of PAH's from the ACW site and contributed to the attenuation of PAH's, phenolic compounds, and nitrogen-containing heterocyclic compounds offsite.

Trace elements were measured in water samples collected from all wells at offsite stations. Barium, cobalt, iron, manganese, nickel, strontium, and zinc were detected most commonly. Concentrations of trace elements were below primary MCL's in all ground-water samples.

To assess the potential for contamination of water-supply sources from the ACW site, 7 wells selected from 50 wells inventoried within a 2-mile radius of the site were sampled for water-quality data. These samples were analyzed for the same organic compounds and inorganic constituents as were the water samples from 36 wells at the six offsite stations. Two municipal wells and an industrial well were sampled, all screened in the Fort Pillow aquifer east (upgradient) of the ACW site.

Tetrachloroethylene, trichloroethylene, chloroform, and other VOC's were detected in water samples from these wells. The detection of these compounds, which are not commonly associated with the wood-preserving processes, is problematic inasmuch as multiple sources for these compounds exist in the area of the wells.

An industrial well screened in the alluvial aquifer in immediate proximity (upgradient) of the ACW site also was sampled. VOC's and relatively high concentrations of some trace constituents, chloride, dissolved solids, and hardness were detected. Degradation of water quality in this well is not directly attributable to contamination from the wood-preserving processes.

A domestic well, an industrial well, and an agricultural-supply well west (downgradient) of the ACW site were sampled for water-quality analysis. No organic or inorganic contaminants were detected in the water samples from these wells, except a low concentration of methylene chloride in one well.

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APPENDIX 1

Field Work and Procedures

APPENDIX 1: FIELD WORK AND PROCEDURES

Field work performed for the offsite ground-water investigation at the American Creosote Works (ACW) abandoned plant site included: (1) inventorying water-supply wells within a 2-mile radius of the site, (2) drilling and geophysical logging 9 stratigraphic test holes at 6 offsite stations (OSGW1 through OSGW6) and 3 onsite stations (4, 6 and 7), (3) collecting ground-water samples using Direct Push Technology (DPT) methods at the 6 offsite stations and analyzing these samples using gas chromatography with photo-ionization detection (GC/PID) and high-performance liquid chromatography (HPLC) methods, (4) measuring water levels in 33 onsite monitoring wells and 36 offsite wells and maintaining continuous water-level recorders on 2 onsite wells, (5) installing and developing 36 wells at the 6 offsite stations, (6) sampling the 36 offsite wells and 7 water-supply wells within a 2-mile radius of the ACW site. A description of these tasks and the general procedures followed are summarized below.

Water-Well Inventory

An inventory of domestic, commercial, industrial, agricultural, municipal, and unused water-supply wells within a 2-mile radius of the ACW site was conducted by the U.S. Geological Survey (USGS) from June through August 1990. This was a follow-up of an inventory of water wells located in this area for the RI/FS (S&ME, Inc., 1988). The USGS inventory was limited to wells for which driller's records were available in the files of the U.S. Geological Survey (USGS), Tennessee Department of Environment and Conservation (TDEC) (Division of Ground Water Protection), and the Jackson Utility Division (JUD). Records of a few wells with potential for water-quality sampling also were obtained from water-well contractors.

Fifty wells with records were located in the field on USGS 7 1/2-minute topographic quadrangles. During the inventory, many other wells were located for which records were not available from government sources.

Stratigraphic Test Holes

An onsite stratigraphic test hole (Md:G-326) was drilled in May 1990 using the hydraulic-rotary method by Wilson Well Company, Inc., Whiteville, Tennessee. Samples of the cuttings from the test hole were collected

every 10 feet, to a total depth of 245 feet. Electric and natural-gamma ray geophysical logs were made in the uncased test hole by USGS. The test hole then was completed as a water-level observation well, using 4-inch polyvinyl chloride (PVC) casing and screen. The screen was set from 134 to 154 feet below land surface.

Eight stratigraphic test holes were drilled by the USGS during October through November 1991. A test hole was drilled at each of the six offsite stations (OSGW1 through OSGW6) and onsite stations 4 and 6. Four-inch-diameter test holes were drilled by the hydraulic-rotary method using a trailer-mounted Central Mine Equipment (CME) Model 55 drilling rig. A Gel-X bentonite mixed with JUD city water was used as the drilling fluid. During the drilling, samples of cuttings from the test holes were collected at 10-foot intervals.

When total depth was reached, the drill stem was removed from the bore hole, and electric and natural-gamma ray geophysical logs were made in each test hole. The test holes were then abandoned, and the bore holes backfilled to land surface with a cement/bentonite-grout mixture.

DPT Methods of Exploration and Sampling

Direct Push Technology (DPT) subsurface exploration and sampling methods were conducted at offsite stations OSGW1 through OSGW6 during July through August 1992. A previous evaluation of these methods at onsite stations 2 and 5 (Parks and others, 1993) resulted in a decision to use these methods at the six offsite stations to the depth of refusal of the DPT equipment. The DPT work at the six offsite stations consisted of four components: (1) collection of lithologic data with the piezocone tool, (2) collection of ground-water samples using the Hydrocone tool, (3) field analysis of ground-water samples collected with the Hydrocone tool by the GC/PID method, and (4) laboratory analysis of splits of these samples by the HPLC method.

Lithologic data was collected at each of the six offsite stations by pushing the Piezocone tool to the depth of refusal of the DPT equipment. Point-stress, sleeve-friction, and pore-pressure data recorded as the tool was pushed through the sediments were used to identify lithologies and determine water levels. Five to seven 1-foot sampling intervals at each station were selected from this data for collection of ground-water samples with the Hydrocone tool. Hydraulic conductivity of the sampling intervals was estimated from filling rates of the Hydrocone tool as the samples were collected.

Headspace analyses of ground-water samples collected from each sampling interval were made in the

field for a reduced list of VOC's from modified USEPA Methods 601 and 602 using the contractor's GC/PID. In addition, splits of the ground-water samples were collected with the Hydrocone tool for analysis of selected creosote and PCP related organic compounds using HPLC methods. The results of the GC/PID and HPLC analyses were used to refine previously selected screen depths for wells installed at the six offsite stations at depths shallower than about 40 feet.

Well Installation and Development

Thirty-six monitoring wells were installed at the six offsite stations by the USGS during June through August 1992 using a trailer-mounted CME Model 55 drilling rig. These wells were installed in clusters of six wells at each of the six offsite stations where the stratigraphic test holes were drilled and the DPT work was conducted.

Shallow wells (13 to 42 feet deep) at each station were installed by augering methods. Clean, 3 1/4- or 6 1/4-inch inside diameter, hollow-stem augers with a removable plug in the bit were used to drill these wells. Augers of this size allowed for an appropriate length of nominal 2-inch inside diameter Schedule 40 threaded and flush-jointed PVC casing and screen to be installed inside the augers to the completion depth of each well. Five-foot long, 0.010-inch slot screens were used for the shallow wells. Clean, 2-inch-diameter casing and screen with a drive point were lowered to the bottom of the augers. The plug in the bit was pushed out using the drive point attached to the bottom of the screen. The augers were pulled back about 7 feet to a point where the bit was about 2 feet above the top of the screen.

It was planned to pour a clean, well-graded sand through the augers to pack the annular space from the bottom of the hole to a point 2 feet above the top of the screen (bottom of the augers). In most cases, collapse of the bore hole around the screen and casing occurred too rapidly to pour a sand pack around the screen. However, a weighted tape was used to measure the depth to the top of the collapse to insure that it was at least 2 feet above the top of the screen. Bentonite pellets (1/2-inch diameter) then were emplaced above the sand pack through the augers to form at least a 2-foot thick seal above the sand pack and around the casing. A neat-cement grout consisting of a mixture of about 6 gallons of potable water per 94-pound bag (1 cubic foot) of Portland Type I cement (creating a grout weight of about 15.5 pounds per gallon) was prepared. This grout was pumped with a pressure-grouting machine through a hose lowered to the base of the augers, and grouting was conducted as each 5-foot auger flight was extracted from the auger hole. By this method, the auger hole was

backfilled with cement grout from the top of the bentonite seal to land surface.

Deep wells (46 to 148 feet deep) at each station were installed by the hydraulic-rotary method. Gel-X bentonite mixed with JUD city water was used as the drilling fluid. Clean drilling tools were used to drill a nominal 8-inch-diameter hole to the desired completion depth of each well. Once completed, the appropriate length of clean, nominal 4-inch inside diameter Schedule 40 threaded and flush-jointed PVC casing and screen was connected together and lowered to the bottom of the hole. Ten-foot long, 0.010-inch slot screens for the deep wells. JUD city water was pumped down the casing and out through the screen to flush the drilling mud from the casing and thin the mud in the annular space. A clean, 1-inch-diameter PVC tremie pipe then was placed in the annular space and a sand pack, bentonite-slurry seal, and neat-cement grout were installed around the casing and screen in each deep well, similar to that installed in the shallow wells.

The wells then were capped and 7-foot-long, 4-inch-diameter, lockable, steel well protectors were installed over the wells. The well protectors were anchored about 2 feet below land surface and extended about 5 feet above land surface to accommodate seasonal high water in the offsite areas. Finally, a cement apron 4-feet square and 4-inches thick was poured around the well protectors to seal the well from contamination from surface sources.

Development of the wells consisted of alternating pumping and recovery of the wells to remove materials smaller than the screen slot-opening width from the adjacent sand packs and formations. Development of the shallow wells was conducted using a 2-inch centrifugal pump. Water-level drawdowns in the deep wells exceeded the depth at which the centrifugal pump could be used. Therefore, these wells were developed with a 4-inch submersible pump. All wells were pumped until they produced clear, sediment-free water.

Water-Level Measurements

Water-level measurements were made with an electric tape. After each measurement, the tape was decontaminated before measuring the next well. The probe was washed with a Liquinox and de-ionized water solution, followed by a de-ionized water rinse, a pesticide-grade methanol rinse, and a high purity organic-free water rinse. Water-level measurements were made in the 36 offsite wells prior to sampling for water quality to provide data from which the volumes of water to be evacuated from the wells could be calculated and the pump-setting depths could be determined. Water-level

measurements in the 33 onsite wells were made after the 36 offsite wells to lessen the chances of cross-contamination.

Well Sampling for Water Quality

Prior to sampling the 36 offsite wells, all equipment was decontaminated. A submersible pump used to evacuate some of the wells was decontaminated by pumping copious amounts of a Liquinox soap and JUD city water solution followed by JUD city water and finally de-ionized water. Other sampling equipment (centrifugal pump intake and bailer wire) that contacted the water samples was decontaminated with a Liquinox soap and JUD city water solution, followed by rinsing with de-ionized water, pesticide-grade methanol, and high purity organic-free water. Equipment that contacted water for inorganic analysis only was decontaminated with a Liquinox soap and de-ionized water solution followed by a rinse with de-ionized water. The sample-split churn also was rinsed with water from the next well sampled.

Wells were purged of a minimum of three casing volumes of water before sampling and until measurements of pH, specific conductance, and temperature had stabilized. A centrifugal pump fitted with a 6-foot long, stainless steel-tube intake (for easy decontamination) was used to purge wells. When water-level drawdowns were greater than the suction lift of this pump, a 2-inch stainless-steel submersible pump was used to evacuate the wells. During purging, pumping rates were generally about 1 gallon per minute.

Ground-water samples were collected with disposable Teflon bailers. The bailer wire was stainless-steel with a Teflon sheath that was decontaminated before use at the next well, following the procedure described above. Samples for dissolved inorganic analyses were filtered through a 0.45-micron filter and preserved with nitric acid to lower the pH to less than 2. Ground-water samples for VOC and SVC analysis were chilled immediately after collection and sent by overnight mail to the USGS laboratory.

Ten quality control/quality assurance samples were collected during the sampling. Three of these samples were duplicate ground-water samples, three were trip blanks, and four were field-equipment blanks. The field-equipment blanks consisted of high-purity organic-free water that had been rinsed over the equipment used to collect the samples.

VOC analyses for water samples from 24 wells sampled at stations OSGW1, OSGW2, OSGW3, and

OSGW6 showed concentrations of 1 to 3 $\mu\text{g/L}$ of toluene in all of the samples, including a field-equipment blank. Once this problem was identified, sampling was stopped and efforts were made to determine the cause of the toluene QA/QC problem. The source was not determined, and after a 2-week hiatus, sampling resumed with minor changes: (1) a different source of high purity organic-free rinse water was used and (2) the disposable bailers were rinsed with high purity organic-free water before use. Analyses of successive samples collected at stations OSGW4 and OSGW5 did not detect toluene at concentrations above the detection limit (0.2 $\mu\text{g/L}$), indicating that the QA/QC problem had been resolved.

To confirm that detection of toluene was a QA/QC problem during the earlier sampling, wells OSGW1-2, OSGW1-6, OSGW2-3, OSGW2-6, OSGW3-2, OSGW3-6, OSGW6-2, and OSGW6-6 were resampled January 6 and 7, 1993, and re-analyzed for VOC's. Wells OSGW1-2, OSGW2-3, OSGW3-2, and OSGW6-2 were selected for resampling because these wells had the highest concentrations of toluene measured in samples from the alluvial aquifer. Wells OSGW1-6, OSGW2-6, OSGW3-6, and OSGW6-6 were selected because these were the deepest wells screened in the Fort Pillow aquifer in which toluene had been measured. Concentrations of toluene in the second set of water samples from these wells were below the detection limits, except for a concentration of 0.3 $\mu\text{g/L}$ in well OSGW6-2.

General procedures followed during the sampling of the 7 offsite water-supply wells within a 2-mile radius of the American Creosote Works abandoned plant site were similar to the procedures for the 36 offsite wells, except the water-supply wells were pumped for at least 1 hour before sampling. Equipment that contacted water samples collected for inorganic analysis was decontaminated with a Liquinox soap and de-ionized water solution followed by a rinse with de-ionized water. The sample-split churn also was rinsed with water pumped from the next well to be sampled. Prior to sampling, the wells were purged using a minimum of three casing volumes and until measurements of pH, specific conductance, and temperature stabilized. Water samples were collected from discharge points as close to the well as possible.

The existing pump in well W14 did not work and prevented the use of the submersible or centrifugal pump. Therefore, the well was purged and sampled with a peristaltic pump, which could have caused a decrease in the VOC concentrations as a result of the vacuum created when the pump is used. The slow pumping rate precluded pumping three casing volumes of water prior to sampling, but measurements of pH, temperature, and specific conductance had stabilized.

APPENDIX 2

Lithologic and geophysical logs for stratigraphic test holes drilled at 3 onsite and 6 offsite stations and well construction diagrams for 36 wells installed at the 6 offsite stations, American Creosote Works abandoned plant site at Jackson, Tennessee

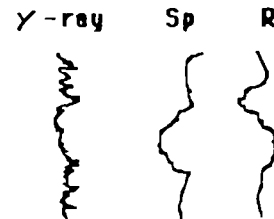
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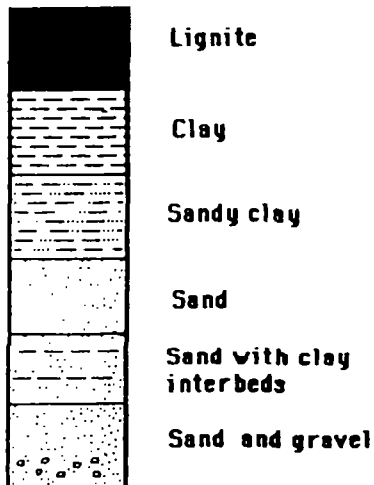
EXPLANATION

GEOPHYSICAL LOGS

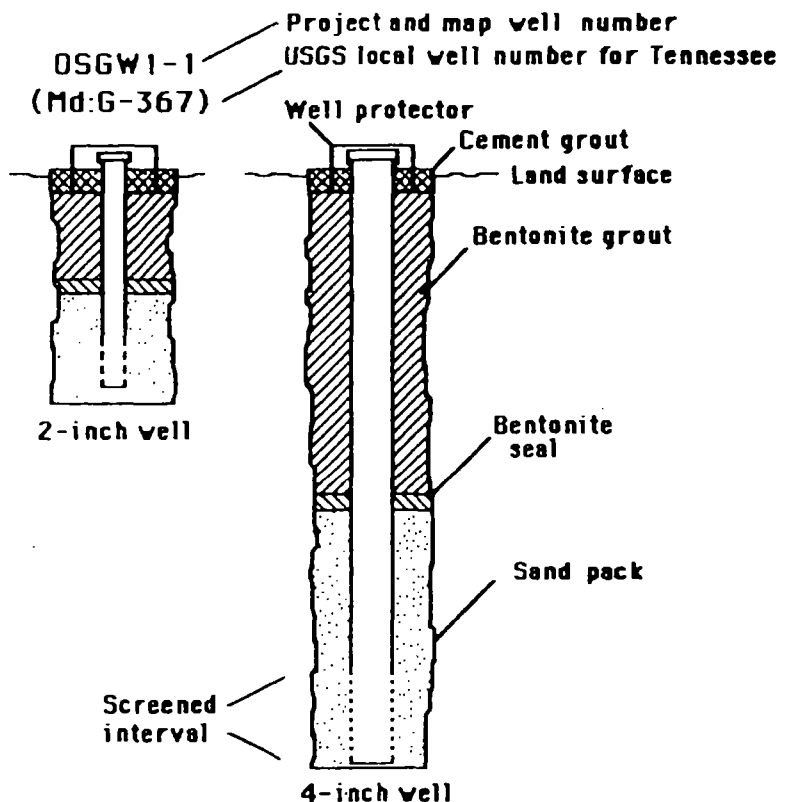
γ -ray NATURAL GAMMA-RAY LOG. RADIOACTIVITY INCREASES \longrightarrow
 Sp SPONTANEOUS POTENTIAL OF ELECTRIC LOG
 R RESISTANCE OF ELECTRIC LOG



LITHOLOGIC SYMBOLS



Lithology is from driller's logs, geophysical logs, and 10-foot-interval samples. Descriptions of colors are from the "Rock Color Chart" of the Geological Society of America. Sand sizes are from a visual comparison card based on the Wentworth grade scale of particle size.



Observation wells at the six offsite stations near the American Creosote Works abandoned plant site are constructed with 2- and 4-inch polyvinyl chloride (PVC) casing and screens. The wells were developed with a submersible and centrifugal pump until the wells produced clear, sediment-free water.

OFFSITE STRATIGRAPHIC TEST HOLE 1 (Md: G-359) AT STATION OSGW1

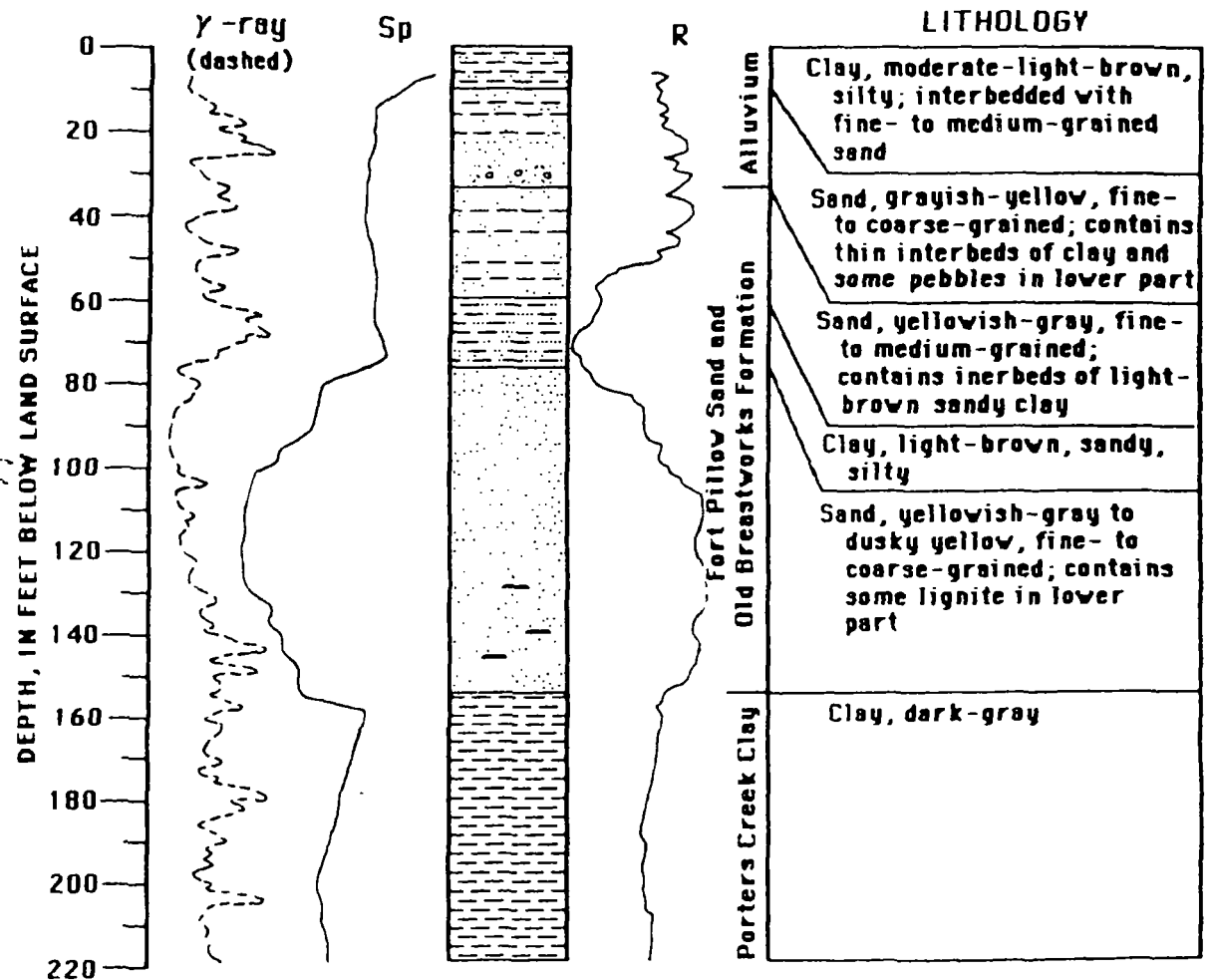
Location: About 1,200 feet east of the South Fork Forked Deer River
and 200 feet south of the Seaboard Railroad

Latitude: 35 36'28" Longitude: 88 50'05"

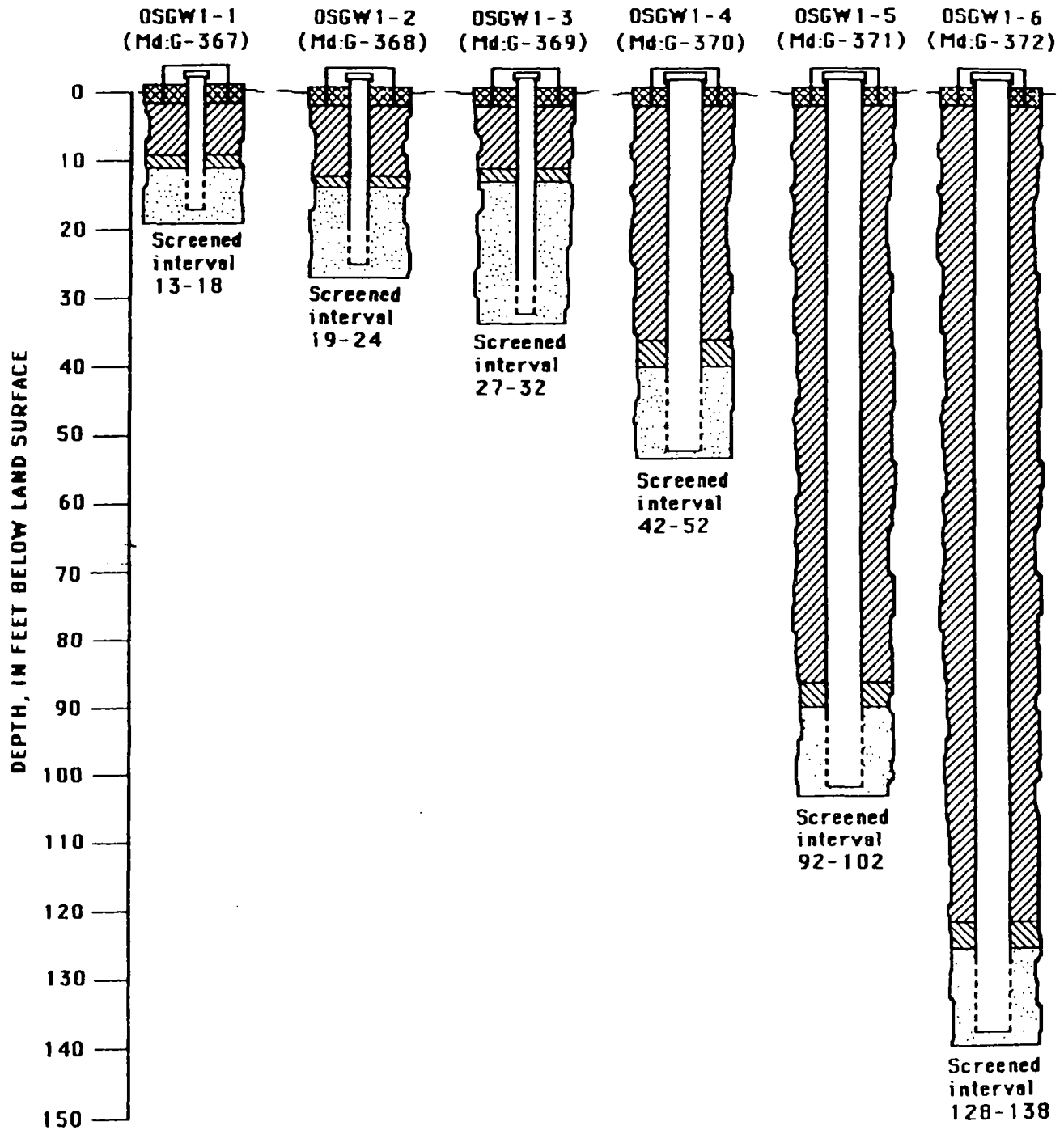
Altitude of land surface: 343 feet above sea level

Date completed: October 8, 1991

Total depth reached: 218 feet below land surface



STATION OSGW1



OFFSITE STRATIGRAPHIC TEST HOLE 2 (Md: G-360) AT STATION OSGW2

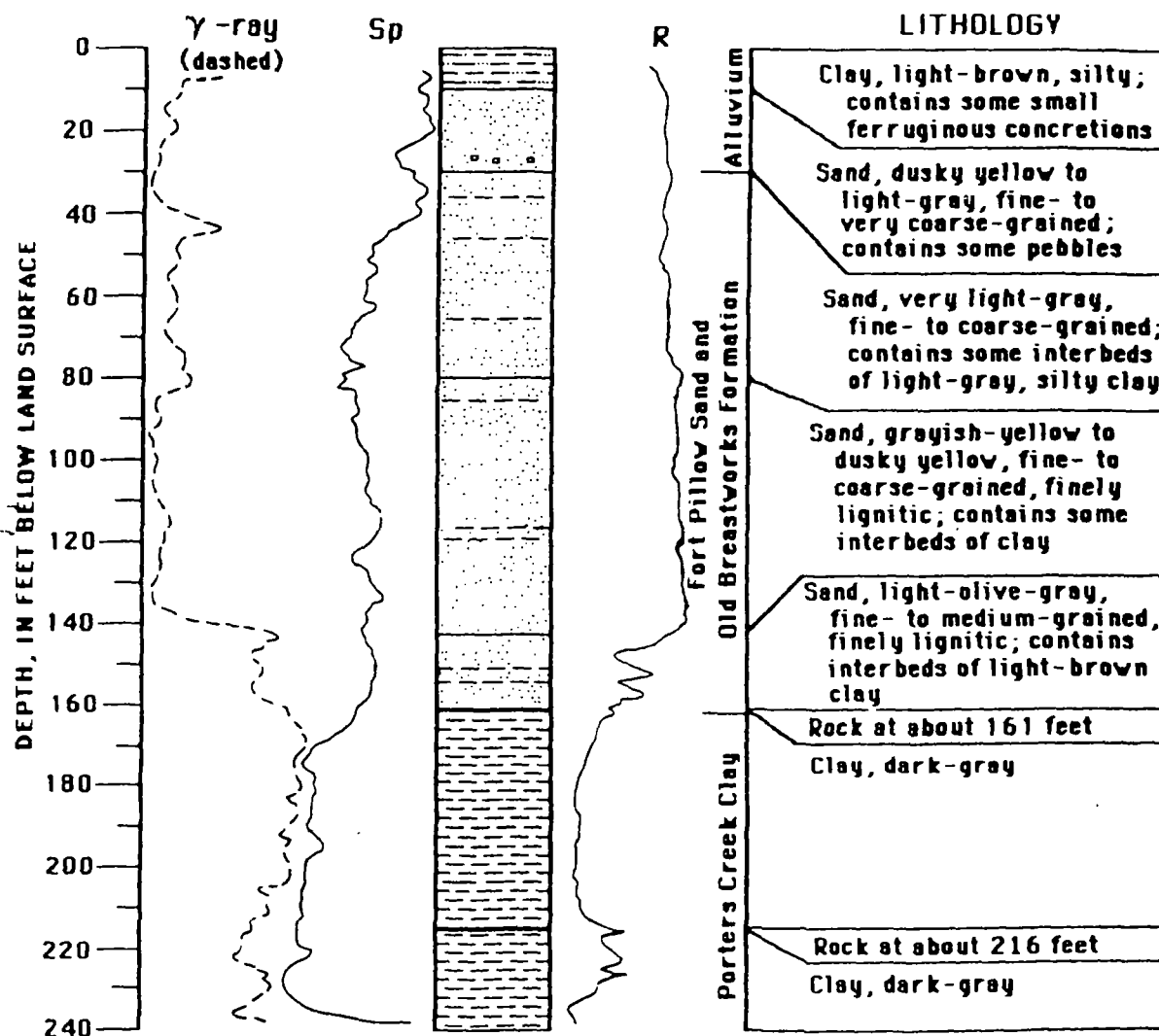
Location: About 700 feet east of the South Fork Forked Deer River
and 200 feet south of the Seaboard Railroad

Latitude: 35 36'27" Longitude: 88 50'11"

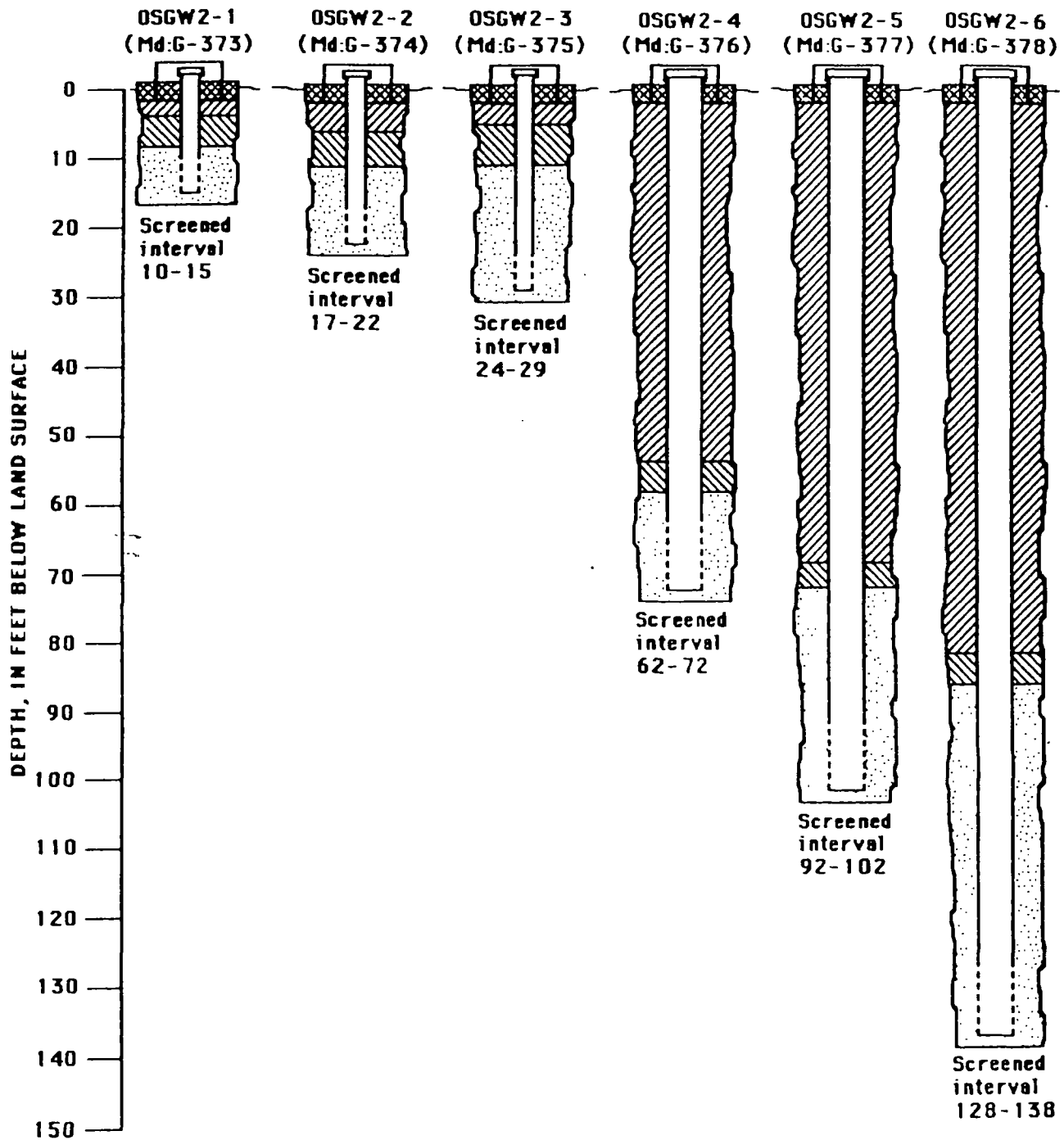
Altitude of land surface: 342 feet above sea level

Date completed: October 10, 1991

Total depth reached: 240 feet below land surface



STATION OSGW2



OFFSITE STRATIGRAPHIC TEST HOLE 3 (Md: G-361) AT STATION OSGW3

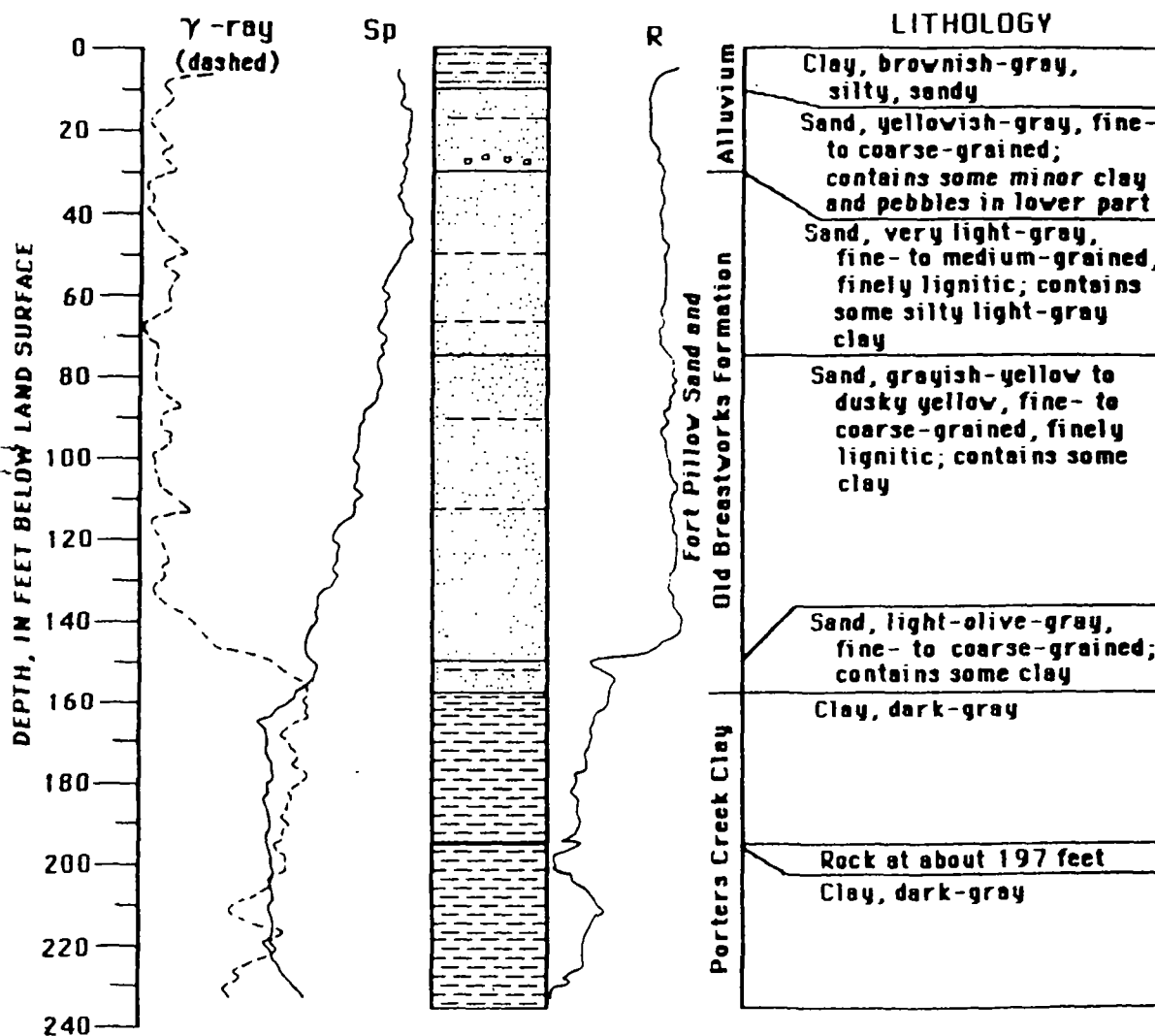
Location: about 300 feet east of the South Fork Forked Deer River
and 200 feet south of the Seaboard Railroad

Latitude: 35 36'27" Longitude: 88 50'16"

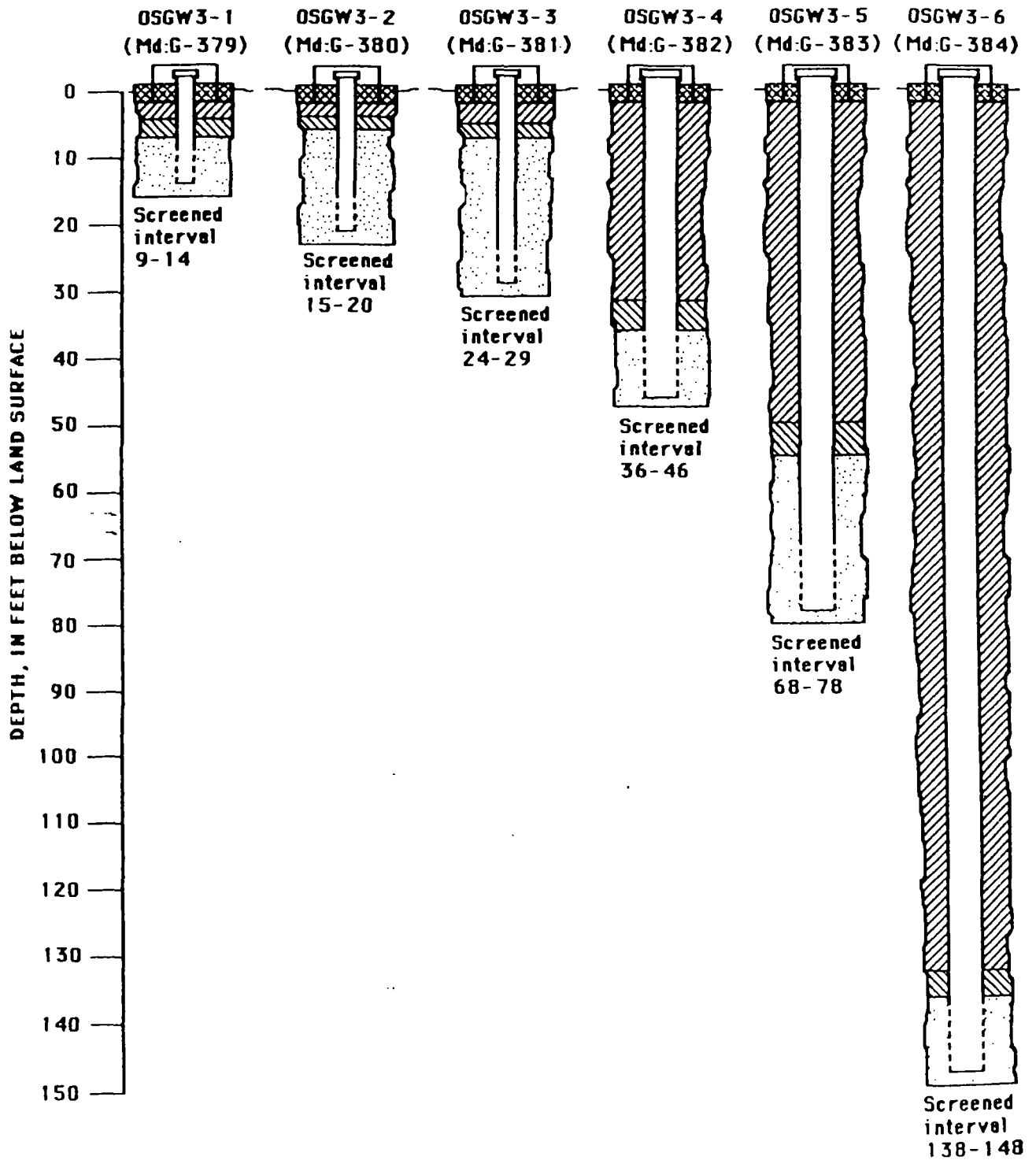
Altitude of land surface: 341 feet above sea level

Date completed: October 22, 1991

Total depth reached: 236 feet below land surface

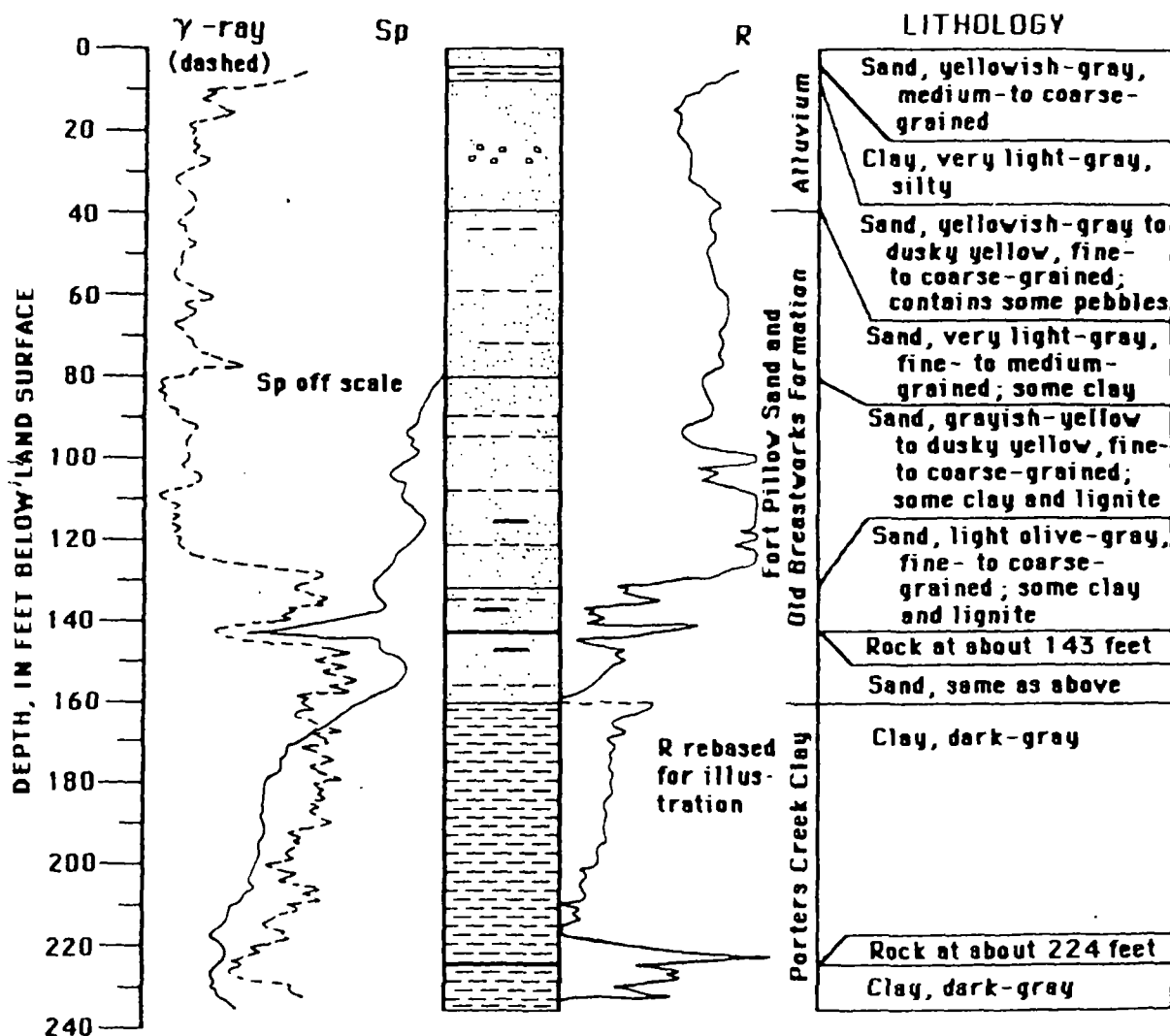


STATION OSGW3

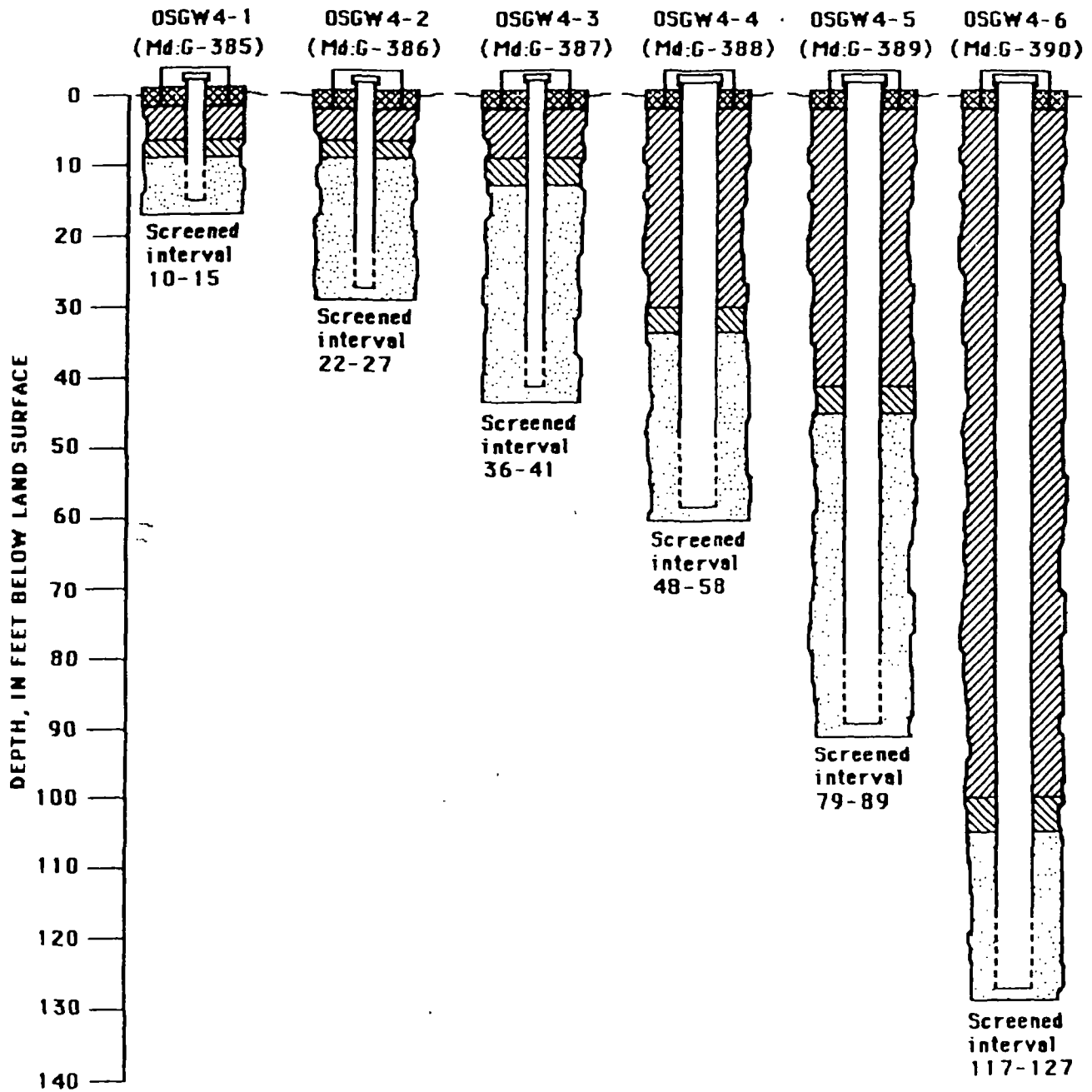


OFFSITE STRATIGRAPHIC TEST HOLE 4 (Md: G-362) AT STATION OSGW4

Location: About 300 feet west of Central Creek and
300 feet north of the Seaboard Railroad
Latitude: 35 36'32" Longitude: 88 50'21"
Altitude of land surface: 343 feet above sea level
Date completed: October 24, 1991
Total depth reached: 236 feet below land surface



STATION OSGW4



OFFSITE STRATIGRAPHIC TEST HOLE 5 (Md: G-363) AT STATION OSGW5

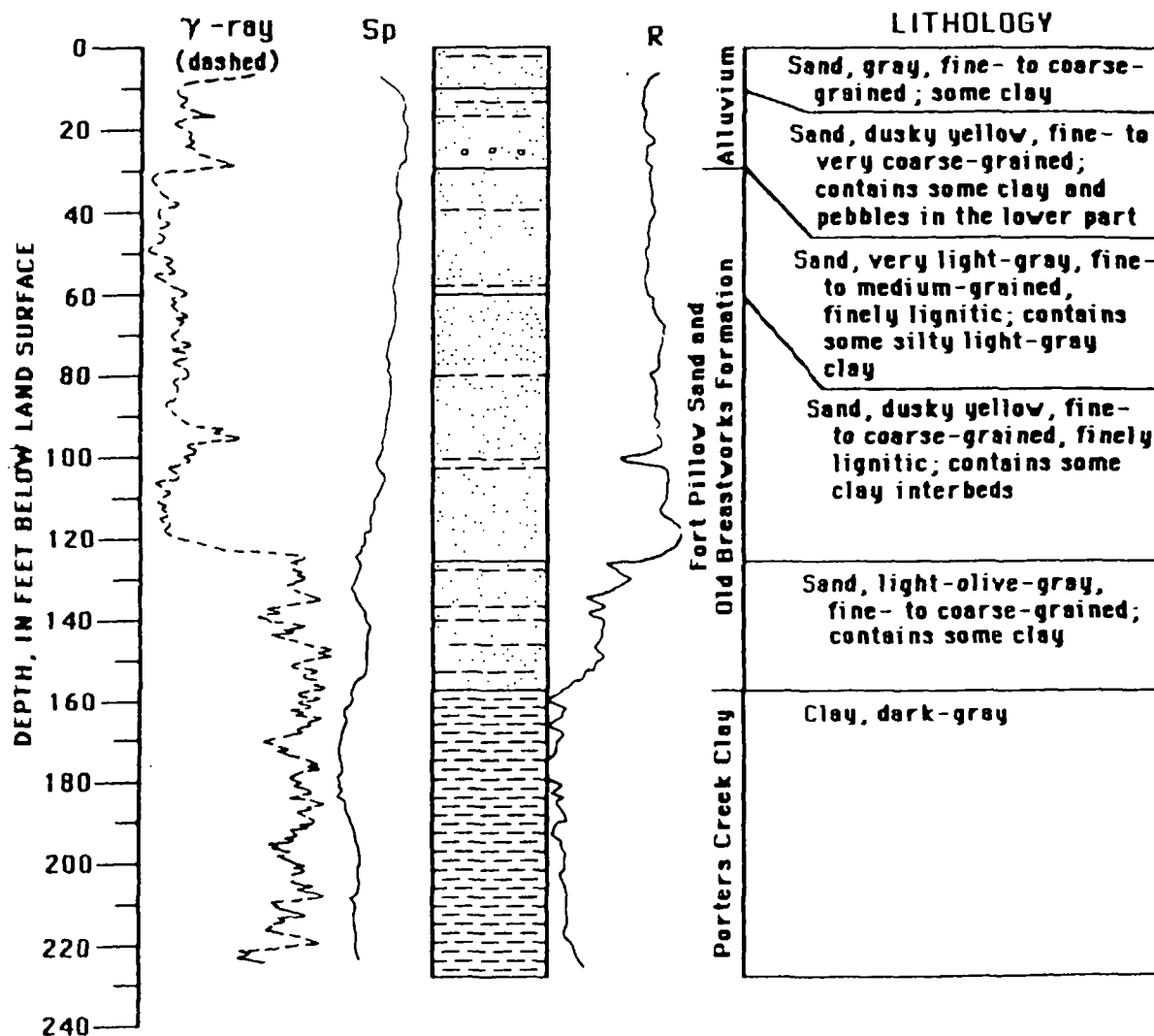
Location: About 100 feet west of Central Creek and
700 feet north of the Seaboard Railroad

Latitude: 35 36'37" Longitude: 88 50'21"

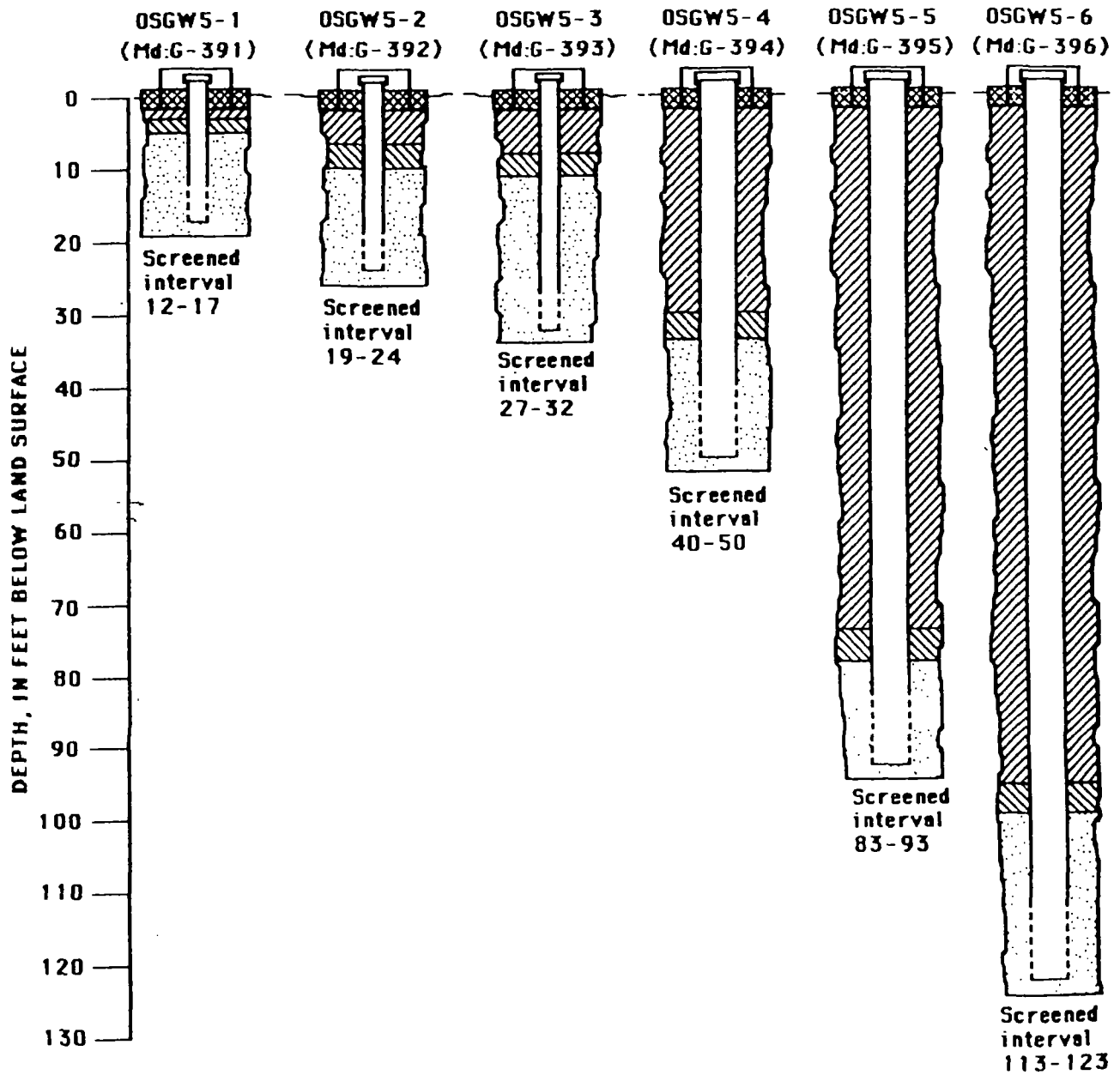
Altitude of land surface: 342 feet above sea level

Date completed: October 27, 1991

Total depth reached: 228 feet below land surface

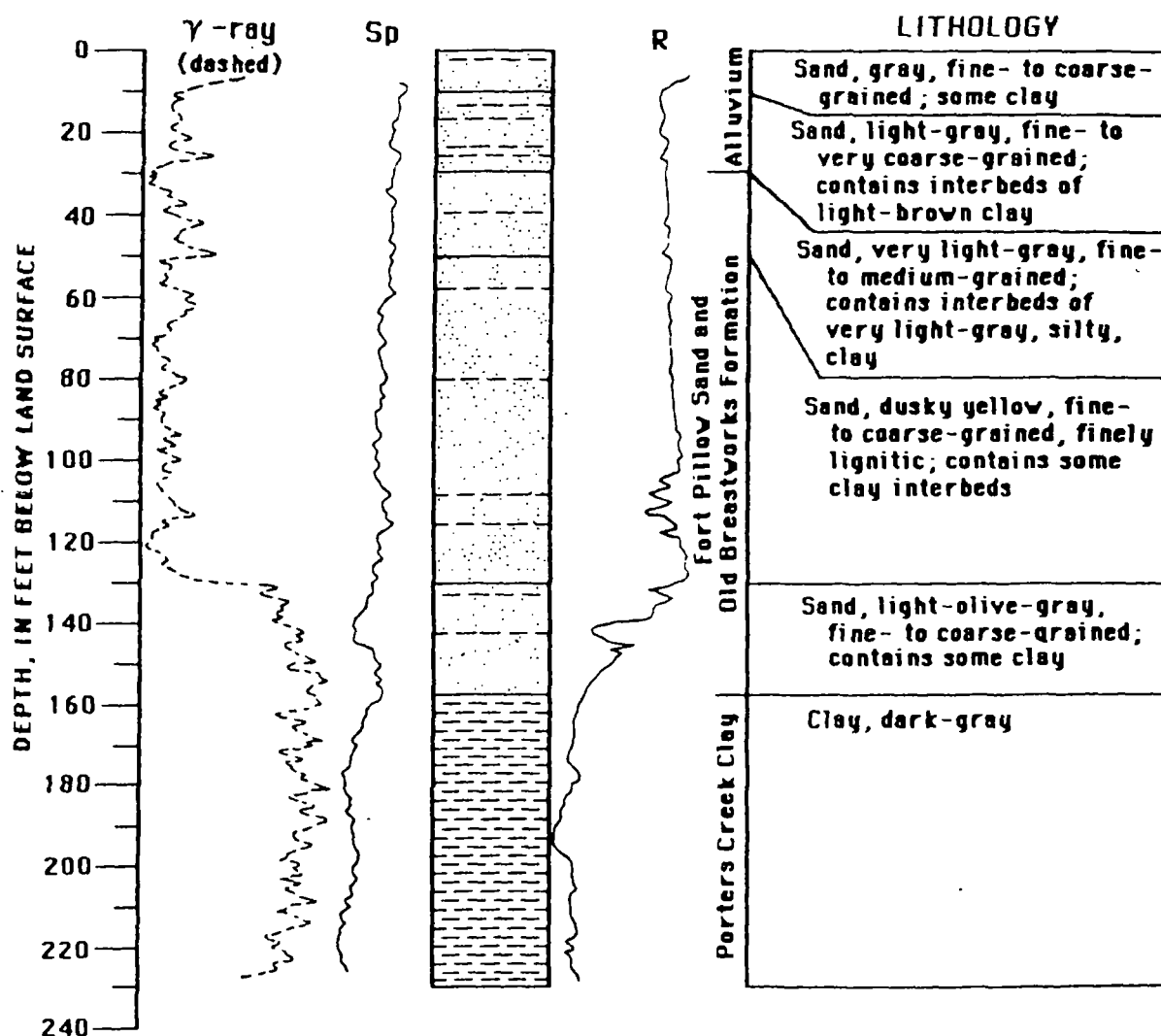


STATION OSGW5

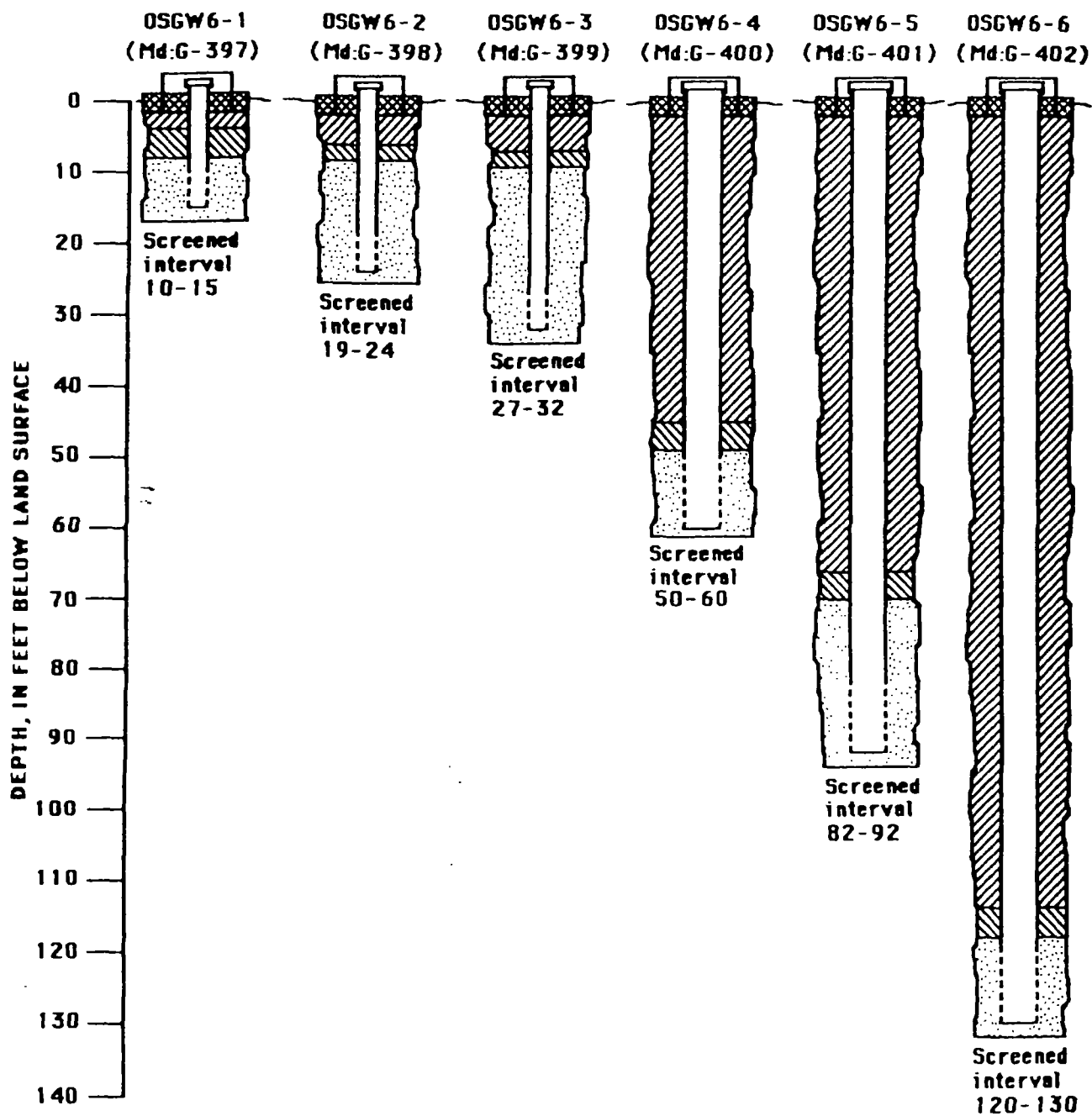


OFFSITE STRATIGRAPHIC TEST HOLE 6(Md: G-364) AT STATION OSGW 6

Location: About 200 feet west of Central Creek and
1,000 feet north of the Seaboard Railroad
Latitude: 35 36'39" Longitude: 88 50'23"
Altitude of land surface: 342 feet above sea level
Date completed: October 25, 1991
Total depth reached: 229 feet below land surface



STATION OSGW6



ONSITE STRATIGRAPHIC TEST HOLE 1 (Md: G-326) AT STATION 7

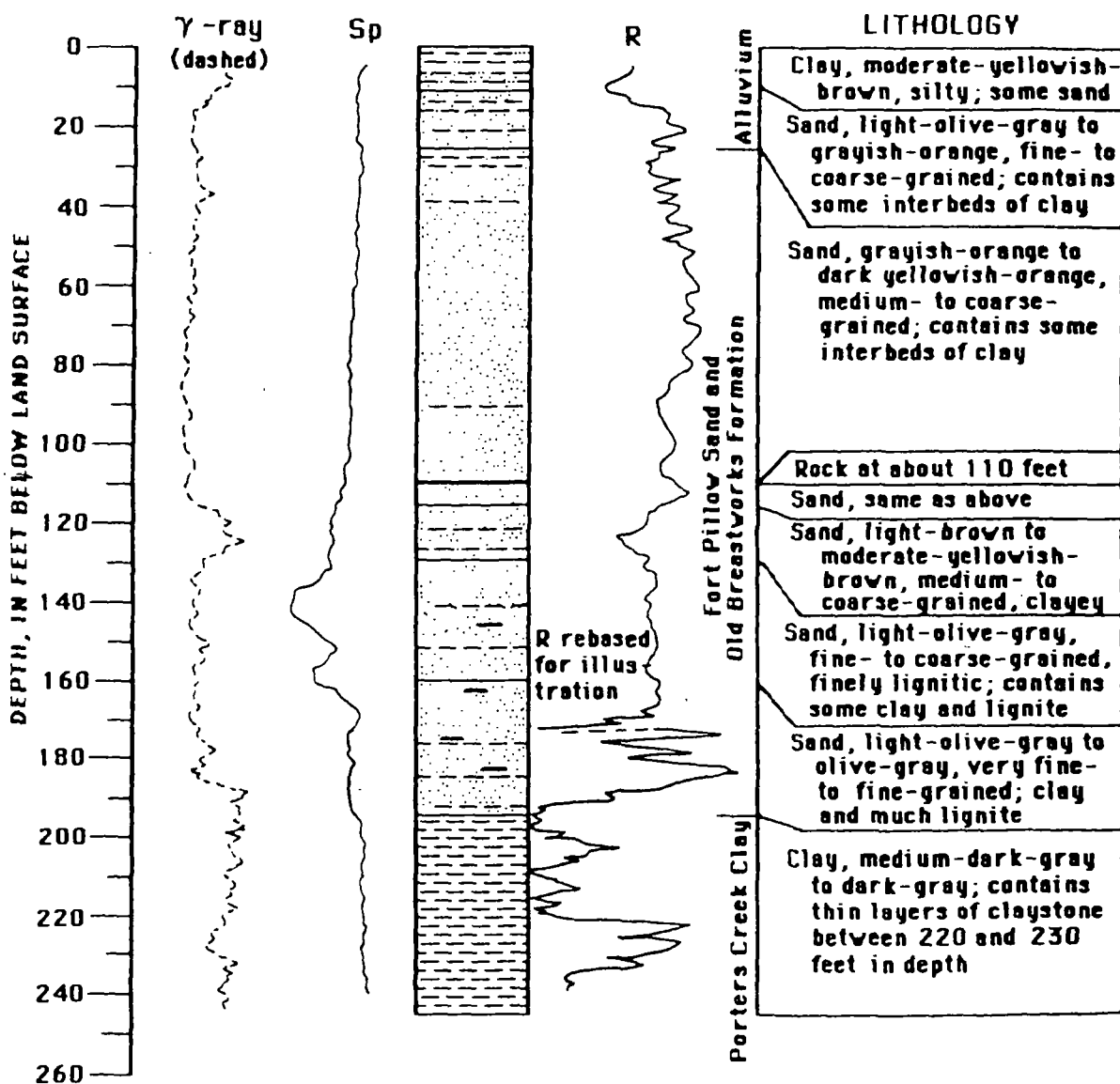
Location: In the northeast part of the American Creosote Works site near monitoring wells 7 and AMW-1

Latitude: 35 36'38" Longitude: 88 49'55"

Altitude of land surface: 348 feet above sea level

Date completed: May 15, 1990

Total depth reached: 245 feet below land surface



ONSITE STRATIGRAPHIC TEST HOLE 2 (Md: G-365) AT STATION 4

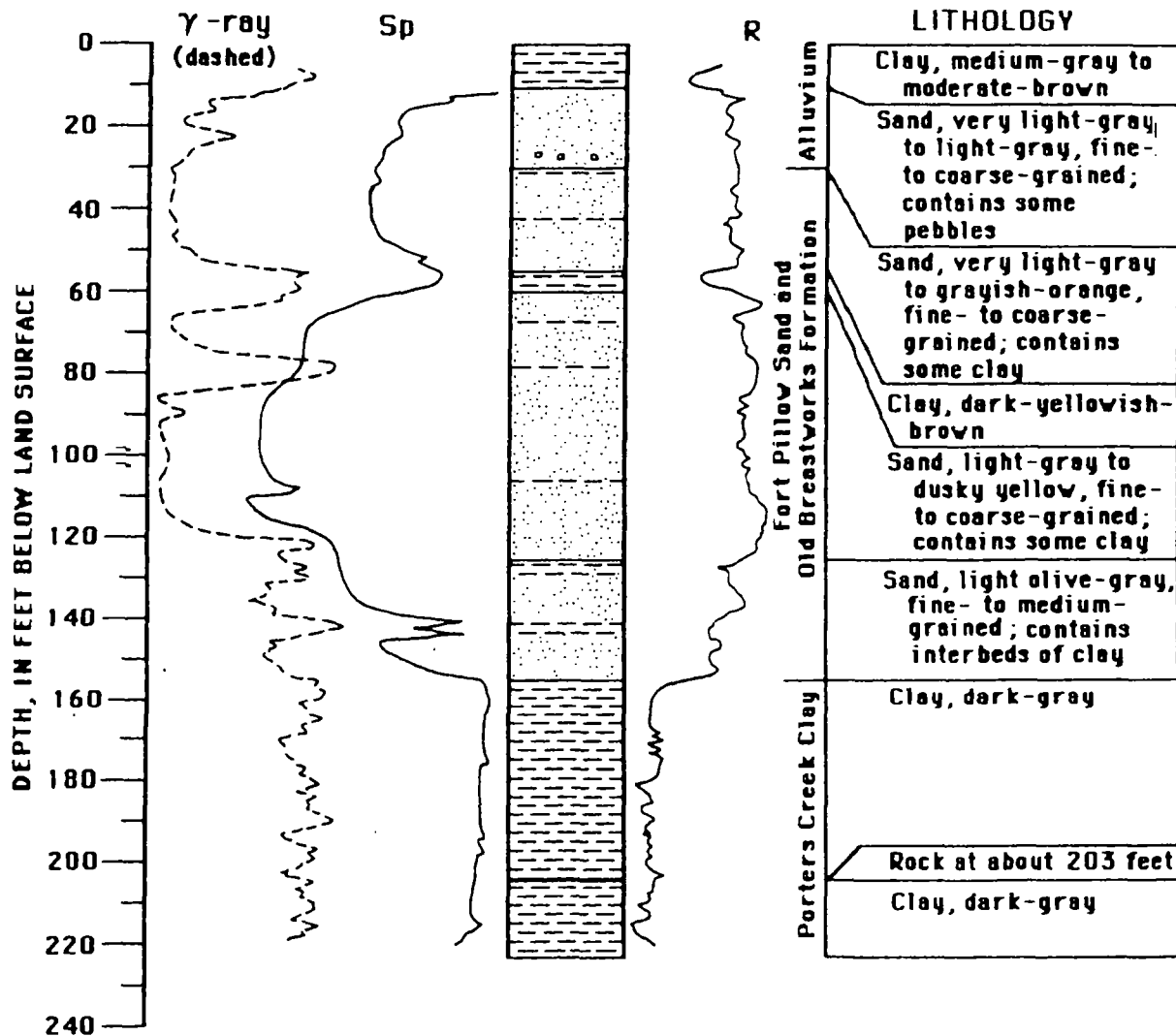
Location: In the northern part of the American Creosote Works site about 50 feet south of monitoring wells 4S, 4M, and 4D

Latitude: 35 36'42" Longitude: 88 50'08"

Altitude of land surface: 344 feet above sea level

Date completed: November 19, 1991

Total depth reached: 223 feet below land surface



ONSITE STRATIGRAPHIC TEST HOLE 3 (Md: G-366) AT STATION 6

Location: In the southern part of the American Creosote Works site
about 100 feet north of the Seaboard Railroad

Latitude: 35 36'31" Longitude: 88 50'03"

Altitude of land surface: 346 feet above sea level

Date completed: November 20, 1991

Total depth reached: 218 feet below land surface

